US Army Corps of Engineers ®
Portland District

Salmon Recovery through John Day Reservoir

John Day Drawdown
Phase I Study

Economic Analysis Technical Appendix
Regional Section






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JOHN DAY DAM DRAWDOWN PHASE 1 STUDY

REGIONAL ECONOMIC ANALYSIS

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Executive Summary

Changes in water management of the John Day Dam pool will affect industries that depend on the flow of Columbia River water passing through the John Day Dam pool, thereby affecting business activities throughout the Pacific Northwest. This study element is to estimate the regional economic impacts and the resulting changes in business activity. The effect on business activity may be negative for some components of change and positive for others. For example, a change from hydroelectric to fossil fuel power generation may increase consumer energy costs, thereby reducing consumption of other goods and services in the region. Switching the power source would have a negative effect on regional income and employment, but the construction and operation of replacement fossil fuel plants would generate additional regional income and employment. A set of regional input-output models is used to translate changes in final demand for certain goods and services into total (direct, indirect and induced) impacts on regional economies.

The analysis methodology is to first identify the economic sectors most likely to be affected by the management changes (Table E-1). Next, the effects are expressed as direct changes in final demand for the output of these sectors (Table E-2). Finally, the total impacts of the demand changes, including indirect and induced effects, are calculated using the input-output models. The results of the analysis under the proposed management alternatives are reported in terms of changes in employment and personal income in the study regions (Table E-3).

The overall employment impacts are very dependent upon the assumption of irrigated agriculture's reaction to dam removal. Under the assumption that irrigated agriculture could not adjust and all the existing acreage ceases production, a total of 14.81 thousand regional jobs across all affected sectors may be lost (Table E-4). In the short run (one to ten years), a total of 11.49 thousand jobs may be gained, mostly in the construction and railroad industry. Under the alternative scenario, where irrigated agriculture would adjust by constructing a water delivery canal, a total of 5.54 thousand jobs may be lost in all sectors. In the short run, 11.49 thousand jobs may be added to the region and a total of 2.61 thousand jobs may be gained in the long run, mainly in the railroad and fishing industries.

Table E-1. Economic Sectors That May Be Affected By John Day Dam Pool Water Management Alternatives

	Activity	Background and Description	Possible Effects	Sectors Affected
1.	Hydropower	"Hydropower Write up for John Day Drawdown Phase I Study"	The 16 units at John Day Dam are designed to operate through the minimum to maximum pool elevation range. Hydraulic capacity of the plant is 350,000 cfs.	Shift in consumer expenditures. Increase in commercial and industrial electricity costs. Construction of replacement capacity- up to 6 fossil fuel plants: construction costs, operating costs.
2.	Navigation / Transportation	"Inputs to Regional Economic Analysis –HDR"	Transportation shift from truck and barging to rail.	Total tonnage shift from truck and barging to rail.
3 a.	Water Supply – Agriculture	"Economic Analysis of Impacts on Irrigation and M&I Water Supply"	29 irrigators currently irrigate approximately 130,850 acres from John Day Dam pool. There is no specific authorization for irrigation from John Day Dam pool. Irrigated crops include: potatoes, corn, vegetables, row crops and alfalfa.	Two possible scenarios: 1. Farmers go out of business' 2. Farmers stay but construct irrigation canal
3 b.	Water Supply – Municipal and Industrial	"Economic Analysis of Impacts on Irrigation and M&I Water Supply"	The Umatilla and Irrigon fish hatcheries and City of Boardman use water from the pool. There is no specific storage for water supply.	Increase costs for alternative water supply for City of Boardman and for hatcheries.
4.	Anadromous Fish	"Economic Evaluation of Changed Anadromous Fish Harvests"	Production changes upriver from John Day Dam are part of total production of the entire Columbia/Snake/ Willamette Basin. Increased harvestable fish resulting from increased overall survival.	Changes in fish survival and resulting harvests throughout migration range. - commercial - recreational - Columbia River Treaty
5.	Recreation	"Economic Analysis of Impacts on Recreation"	Visitors at recreation sites and facilities along Lake Umatilla exceeded 1.6 million during 1989.	Changes in reservoir fishing days Other visitor day changes
6.	Implementation and Avoidance Costs	Letter from Corps	Increased spending on transitional activities immediately following implementation of management alternatives.	Increased construction activities.

Source: Study.

Table E-2. John Day Dam Drawdown Study: Change in Final Demand ($ mil.) by Sector: Natural River Alternative

	Impact Type		Agriculture Production	Commercial and Industrial Consump. Effect	Household Personal Consump. Effect	Construction Each Year	Local Govt.	Truck Industry	Barge Industry	Railroad Industry	Power Plant Operating Costs (per plant)	Commer-cial Fishing	Recreation Fishing	Recreation Other Recreation
1	Power (87% of Snake River = 6 plants)			($51.9)	($94.1)	$150.0 (each year for 6 years) $ 10.0 (transmission for 1 year)					$26.8			
2	Transportation				($12.2)			($77.5)	($49.0)	$153.2				
3a. 1	Water Supply	Agriculture	($324.6)	(for crop specific impacts, see Table 16)										
3a. 2	Water Supply	Agriculture			($24.57)	$75.0 (canal construction over 5 years)								
3b	Water Supply	M&I			($4.0)	$12.6	$4.0							
4	Anadromous Fish		<<<<<<<<<<<<<<<<<<<< $17.9 (after 30 years) >>>>>>>>>>>>>>>>>>>>											
5	Recreation (in tenth year)												$6.9	$39.1
6	Implementation and Avoidance		$656 (divided between households, wholesale trade, construction and government) (from 1-5 years)											

Notes: 1. The impacts for the lower Snake River dam natural river alternative have been calculated separately and will be additive to the shown impacts.
2. Power plant construction and operating costs are per plant.

Source: Study.

Table E-2. (continued)

	Impact Type	Agriculture Production	Commercial and Industrial Consump. Effect	Household Personal Consump. Effect	Construction Each Year	Local Govt.	Truck Industry	Barge Industry	Railroad Industry	Power Plant Operating Costs (per plant)	Commercial Fishing	Recreation Fishing	Recreation Other Recreation
1	Power (51% of natural river alternative = 3 plants)		($26.5)	($42.9)	$150.0 (each year for 3 years) $ 5.0 (transmission for 1 year)					$26.8			
2	Transportation			($12.2)			($77.5)	($49.0)	$153.2				
3a. 1	Water Supply Agriculture	($324.6)	(for crop specific impacts, see Table 16)										
3a. 2	Water Supply Agriculture			($24.57)	$75.0 (canal construction over 5 years)								
3b	Water Supply M&I			($4.0)	$12.6	$4.0							
4	Anadromous Fish	<<<<<<<<<<<<<<<<<<<< $13.9 (after 30 years) >>>>>>>>>>>>>>>>>>>>											
5	Recreation (in tenth year)											($0.5)	($4.7)
6	Implementation and Avoidance	$440 (divided between households, wholesale trade, construction and government)											

Notes: 1. Impacts for the spillway crest alternative will not be affected by flood control.
2. The impacts for the lower Snake River dam natural river alternative have been calculated separately and will be additive to the shown impacts.
3. Power plant construction and operating costs are per plant.

Source: Study.

Table E-3. John Day Dam Drawdown Study: Income ($ mil.) and Employment (jobs) Impacts: Natural River Alternative

	Impact Type		Agriculture Production	Commercial and Industrial Consump. Effect	Household Personal Consump. Effect	Construction Each Year	Local Govt.	Truck Industry	Barge Industry	Railroad Industry	Power Plant Operating Costs (per plant)	Commercial Fishing	Recreation: Fishing	Recreation: Other Recreation
1	Power (87% of Snake River = 6 plants)			($71.8) -739 jobs	($130.1) -1,334 jobs	$113.2 3,027 jobs					$7.9 292 jobs			
2	Transportation				($15.4) -128 jobs			($43.2) -1,834 jobs	($25.2) -770 jobs	$40.0 2,330 jobs				
3a. 1	Water Supply OR	Agriculture	($350.5) -9,276 jobs											
3a. 2	Water Supply	Agriculture			($31) -257 jobs	$52.4 (for 5 years) 1,395 jobs								
3b	Water Supply	M&I			($3.8) -31 jobs	$8.7 232 jobs (one year)	$1 61 jobs							
4	Anadromous Fish											$26.5 (after 30 years) 717 jobs		
5	Recreation (in tenth year)												$1.75 71 jobs	$10.5 496 jobs
6	Implementation and Avoidance					$125.4 4,957 jobs (1.5 years)								

Notes: 1. Impacts for the spillway crest alternative will not be affected by flood control.
2. The impacts for the lower Snake River dam natural river alternative have been calculated separately and will be additive to the shown impacts.
3. Power plant construction and operating costs are per plant.

Source: Study.

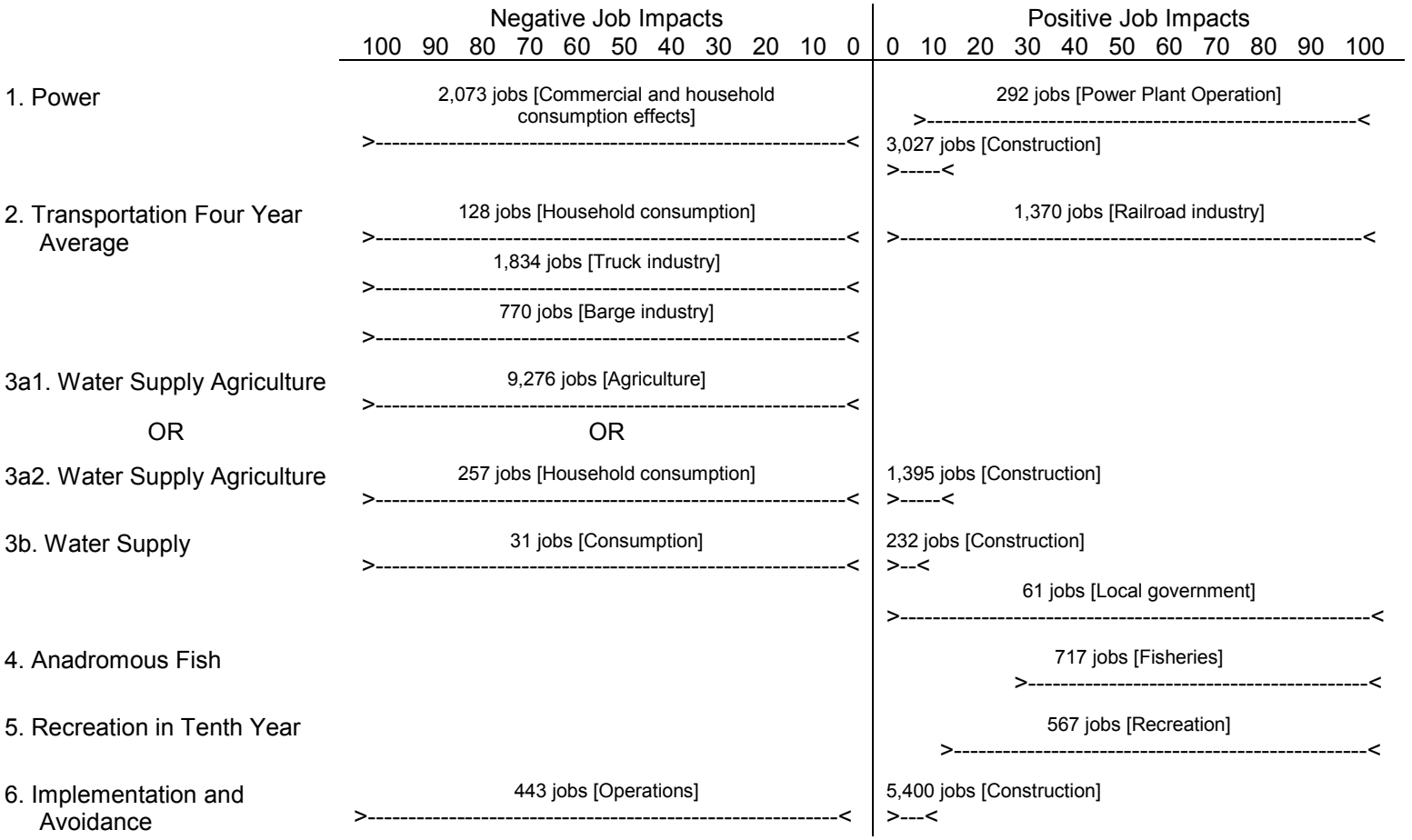
Table E-3. (continued)

	Impact Type		Agriculture Production	Commercial and Industrial Consump. Effect	Household Personal Consump. Effect	Construction Each Year	Local Govt.	Truck Industry	Barge Industry	Railroad Industry	Power Plants Operating Costs (per plant)	Commercial Fishing	Recreation: Fishing	Recreation: Other Recreation
1	Power (51% of natural river alternative = 3 plants)			($36.6) -377 jobs	($66.4) -680 jobs	$109 2,906 jobs					$7.9 299 jobs			
2	Transportation				($15.4) -128 jobs			($43.2) -1,834 jobs	($25.2) -770 jobs	$40.0 2,330 jobs				
3a. 1	Water Supply OR	Agriculture	($350.5) -9,276 jobs											
3a. 2	Water Supply	Agriculture			($31) -257 jobs	$52.4 (for 5 years) 1,395 jobs								
3b	Water Supply	M&I			($3.8) -31 jobs	$8.7 232 jobs (one year)	$1 61 jobs							
4	Anadromous Fish											$20.6 (after 30 years) 557 jobs		
5	Recreation (in tenth year)												($0.12) -5 jobs	($1.3) -59 jobs
6	Implementation and Avoidance					$91.1 3,568 jobs								

Notes: 1. Impacts for the spillway crest alternative will not be affected by flood control.
2. The impacts for the lower Snake River dam natural river alternative have been calculated separately and will be additive to the shown impacts.
3. Power plant construction and operating costs are per plant.

Source: Study.

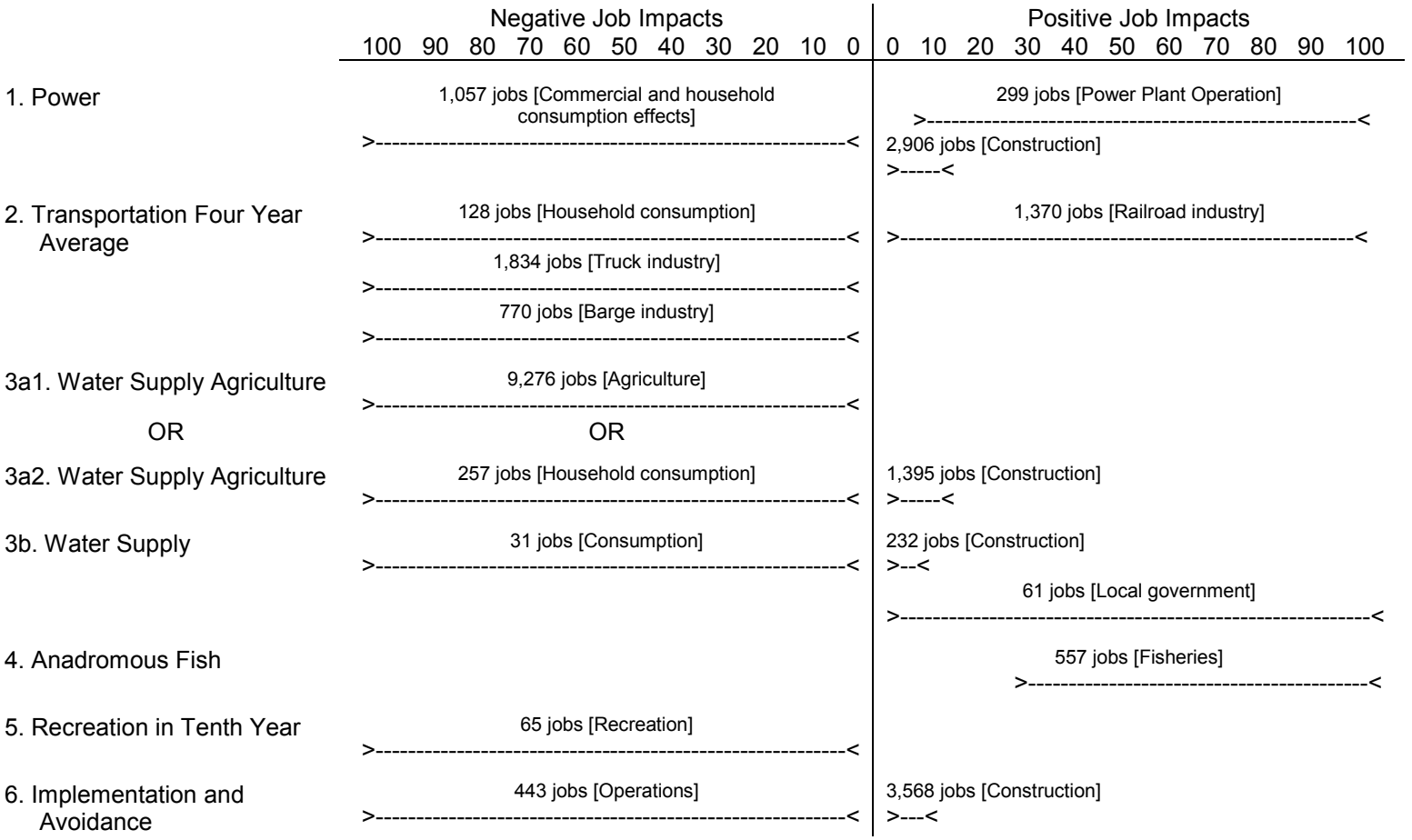
Table E-4a. John Day Dam Drawdown Study: Total Employment (Job) Impacts: Natural River Alternative (B1) by Industrial Sector, Over 100 Years



Notes: 1. Time frame for the Water Supply-Agriculture Sector Scenario 1 is a loss of 14,812 jobs in the first 10 years and a gain of 11,485 jobs in the first 10 years and a gain of 2,610 jobs between project years 30 to 100.
2. Scenario 2 is a loss of 5,535 jobs in the first 10 years and a gain of 11,485 jobs in the first 10 years and a gain of 2,610 jobs between project years 30 to 100.

Source: Study.

Table E-4b. John Day Dam Drawdown Study: Total Employment (Job) Impacts: Spillway Crest Alternative (B2) by Industrial Sector, Over 100 Years



Notes: 1. Time frame for the Water Supply-Agriculture Sector Scenario 1 is a loss of 13,418 jobs in the first 10 years and a gain of 8,137 jobs in the first 10 years and a gain of 1,866 jobs between project years 30 to 100.
2. Scenario 2 is a loss of 4,585 jobs in the first 10 years and a gain of 9,532 jobs in the first 10 years and a gain of 1,866 jobs between project years 30 to 100.

Source: Study.

John Day Dam Drawdown Phase I Study
Regional Economic Analysis

I. INTRODUCTION

1. Methodology

The analysis uses regional input-output models to estimate direct indirect and induced effects of the drawdown alternatives on total regional spending, employment and income. Input-output models are built on the assumption that certain types of economic activity drive the regional economy. This economic or export "base" is defined as activity directly supplying demand from outside the region. A basic activity purchases productive inputs of goods and services, including labor and capital. The extent that regional producers and households supply these goods and services determines the amount of "non-basic" activity generated. It is assumed that non-basic activity is induced, and therefore could not exist without basic activity. In this sense, then, the entire regional economy is "dependent" on the export base.

2. Impact Areas

Six major impact categories were examined in this study: **Power Supply** (constructing and operating alternative electrical generation facilities), **Transportation** (changes from barge to other forms of transport),**Water Supply** (including irrigated agriculture and municipal and industrial supplies), impacts on **Anadromous Fish**, **Recreation** (shift from reservoir-based to river-based activities) and project **Implementation and Avoidance** costs.

3. Geographic Scope of the Analysis

In total eight input-output models were used to analyze possible changes in sales to final demand created by the alternatives. The models include: State of Washington, State of Oregon, State of Idaho, State of Montana, the Upriver subregion, the Reservoir subregion, the Downriver subregion, and the Lower Snake River Region which is the combined Upriver, Reservoir and Downriver subregions. The input-output models were constructed using 1994 IMPLAN data and benchmark data from other sources. All models were built, maintained and run by Agricultural Enterprises, Inc (AEI). The models were used to estimate total regional impacts on sales, employment and personal income. (For a description and listing of the input-output multipliers see the appendix).

The primary study area used in this analysis corresponds to the "Downriver" region used by AEI for the Lower Snake River Juvenile Salmon Migration Feasibility Study.

The specific geographic scope of the study area includes counties in Oregon and Washington that border the John Day pool and the downstream counties extending to the edge of the Portland PMSA. The John Day pool (also called Lake Umatilla) is a segment of the Columbia River that extends from John Day Lock and Dam, located at river-mile 215.6, to McNary Lock and Dam, located at river-mile 291, a distance of 77 miles. Four counties in Oregon (Sherman, Gilliam, Morrow and Umatilla. and two counties in Washington (Klickitat and Benton) border the John

Day pool. Hood River and Wasco counties in Oregon and Franklin and Skamania counties in Washington are included in the study area. (This area corresponds to the Downriver subregion.) The Upriver Subregion includes the Idaho counties of Clearwater, Custer, Idaho, Latah, Lemhi, Lewis, Nez Perce, and Valley, and Wallowa County in Oregon. The Reservoir Subregion is entirely in the State of Washington. The counties included in the Reservoir Subregion are: Walla Walla, Columbia, Garfield and Asotin Counties that are south of the reservoirs and Adams and Whitman Counties north of the reservoirs.[1]

4. Area Description And Land Use

The study area lies east of the Cascade Mountains, which block moisture from Pacific storms. As a result, the climate is semi-arid and there is little natural vegetation. The geography of the region is primarily rolling plains and low hills that are transected by the Columbia River. At the river, elevations range from about 100 to 300 feet above sea level. Agriculture and open space are the dominant land uses. Lands at higher elevations and more distant from the river are suitable for dry land grains and irrigated crops. Lands irrigated from the reservoir are bench lands adjacent to the reservoir. All of these lands that are used for growing crops are irrigated.

5. Profile of the Regional Economy

a. Socio-Economic Profile

Population. In 1980s Oregon and Washington's population grew more rapidly than the study area's population. The Gilliam-Morrow-Umatilla area grew at only about one-third of the rate for the Oregon as a whole and the Benton-Klickitat area grew at less than one-quarter of the rate for Washington. During the 1990s, however, the population growth rate for the study has exceeded the combined growth rate for Oregon and Washington. By 1998 the Gilliam-Morrow-Umatilla area had reached a population of 78.60 thousand and had an annual rate of 1.3 percent since 1990, compared with 1.8 percent for the state. On the north side of the Columbia River, Benton and Klickitat counties had a population growth rate of 2.4 percent from 1990-98, exceeding the rate of growth for the state of 2.0 percent. In 1998 these two counties had a population of 156.60 thousand. Population data and annual growth rates for Oregon and Washington and the counties and communities in the study area for selected years are shown in Table I-1. Population growth in the study area has been fueled largely by an expanding agricultural economy, including food processing activity(?).

Population forecasts show continued growth for both states and the local counties as shown in Table I-2. In the period from 2000 to 2010 Oregon's population is expected to increase about 416.00 thousand and Washington's about 843.00 thousand. Population growth rates for the study area are expected to be slightly lower than for the respective states, with annual growth rates of about 1.02 percent for the area in Oregon and 1.21 percent for the area in Washington. Comparison of these forecasts with growth through 1998 shows that current growth rates are significantly higher than the forecast growth rates.

1. The coastal areas of the Pacific Northwest are included in the Anadromous Fish Study Team study area.

Table I-1. Population for Oregon, Washington and the John Day Dam Study Area

					Annual Growth Rates	
	1980	1990	1993	1998	1980-90	1990-98
Study Area-Total	**193,703**	**200,067**	**213,540**	**235,200**	**0.3%**	**2.0%**
Study Area-Oregon	68,437	70,891	73,200	78,600	0.4%	1.3%
Study Area-Washington	125,266	129,176	140,340	156,600	0.3%	2.4%
Oregon	**2,633,156**	**2,842,321**	**3,038,000**	**3,267,550**	**0.8%**	**1.8%**
Gilliam	**2,057**	**1,717**	**1,750**	**2,100**	**-1.8%**	**2.5%**
Arlington	521	425	475	530	-2.0%	2.8%
Condon	783	635	720	830	-2.1%	3.4%
Lonerock	26	11	15	25	-8.2%	10.8%
Unincorp.	727	646	540	715	-1.2%	1.3%
Hood River	**15,835**	**16,903**	**17,900**	**19,500**	**0.7%**	**1.5%**
Cascade Locks	838	930	1,025	1,095	1.1%	1.8%
Hood River	4,329	4,632	4,725	5,130	0.7%	1.1%
Unincorp.	10,668	11,341	12,150	13,275	0.6%	1.7%
Sherman	**2,172**	**1,918**	**1,850**	**1,900**	**-1.2%**	**-0.1%**
Grass Valley	164	160	165	185	-0.2%	1.6%
Moro	336	292	290	340	-1.3%	1.6%
Rufus	352	295	290	310	-1.6%	0.5%
Wasco	415	374	375	420	-1.0%	1.2%
Unincorp.	905	797	730	645	-1.2%	-1.9%
Morrow	**7,519**	**6,625**	**8,450**	**9,400**	**-1.3%**	**4.5%**
Boardman	1,261	1,387	2,000	2,795	1.0%	9.2%
Heppner	1,498	1,412	1,440	1,500	-0.6%	0.8%
Ione	345	255	245	275	-3.0%	0.9%
Irrigon	700	737	875	1,330	0.5%	7.7%
Lexington	307	286	285	305	-0.7%	0.8%
Unincorp.	3,408	2,548	3,605	3,195	-2.9%	2.9%
Umatilla	**58,861**	**62,549**	**63,000**	**67,100**	**0.6%**	**0.9%**
Adams	240	223	235	275	-0.7%	2.7%
Athena	965	997	1,025	1,200	0.3%	2.3%
Echo	624	500	515	640	-2.2%	3.1%
Helix	155	150	160	190	-0.3%	3.0%
Hermiston	9,408	10,047	10,215	11,595	0.7%	1.8%
Milton-Freewater	5,086	8,833	5,765	6,500	5.7%	-3.8%
Pendleton	14,521	15,142	15,520	16,915	0.4%	1.4%
Pilot Rock	1,630	1,478	1,510	1,640	-1.0%	1.3%
Stanfield	1,568	1,568	1,590	1,820	0.0%	1.9%
Ukiah	249	250	255	245	0.0%	-0.3%
Umatilla	3,199	3,046	3110	3,515	-0.5%	1.8%
Weston	719	606	625	690	-1.7%	1.6%
Unincorp.	20,497	19,709	22,475	21,875	-0.4%	1.3%
Wasco	**21,732**	**21,683**	**22,500**	**22,600**	**0.0%**	**0.4%**
Antelope	39	34	45	65	-1.3%	9.1%
Dufur	560	527	565	620	-0.6%	1.8%
Maupin	495	456	475	490	-0.8%	0.7%
Mosler	340	244	250	335	-2.8%	3.7%
Shaniko	30	26	25	30	-1.3%	1.5%

Table I-1. (continued)

					Annual Growth Rates	
	1980	1990	1993	1998	1980-90	1990-98
The Dalles	10,820	11,021	11,325	11,765	0.2%	0.7%
Unincorp.	9,448	9,375	9,815	9,295	-0.1%	-0.1%
Washington	**4,132,353**	**4,866,663**	**5,240,900**	**5,685,300**	**1.6%**	**2.0%**
Benton	**109,444**	**112,560**	**122,800**	**137,500**	**0.3%**	**2.5%**
Benton City	2,087	1,806	1,950	2,175	-1.4%	2.4%
Kennewick	34,397	42,152	45,110	50,390	2.1%	2.3%
Prosser	4,049	4,476	4,540	4,865	1.0%	1.0%
Richland	33,578	32,315	34,080	36,860	-0.4%	1.7%
West Richland	2,938	3,962	4,510	7,295	3.0%	7.9%
Unincorp.	32,395	27,849	32,610	35,915	-1.5%	3.2%
Klickitat	**15,822**	**16,616**	**17,540**	**19,100**	**0.5%**	**1.8%**
Bingen	679	645	650	698	-0.5%	1.0%
Goldendale	3,575	3,324	3,375	3,550	-0.7%	0.8%
White Salmon	1,853	1,861	1,950	2,011	0.0%	1.0%
Unincorp.	9,715	10,786	11,565	12,841	1.1%	2.2%
Skamania	**7,919**	**8,289**	**9,000**	**9,900**	**0.5%**	**1.9%**
North Bonneville	432	431	458	532	0.0%	2.3%
Stevenson	1,172	1,147	1,155	1,212	-0.2%	0.6%
Unincorp.	6,315	6,711	7,387	8,156	0.6%	2.2%
Franklin	**35,025**	**37,473**	**41,100**	**44,400**	**0.7%**	**1.8%**
Connell	1,981	2,005	2,375	2,780	0.1%	3.9%
Kahlotus	203	167	200	257	-1.8%	5.4%
Mesa	278	252	315	430	-0.9%	7.1%
Pasco	18,428	20,337	21,370	26,090	1.0%	2.8%
Unincorp.	14,135	14,712	16,840	14,843	0.4%	0.1%

Note: Counties are in **boldface** script.

Source: Center for Population Research and Census, Portland State University; and Office of Financial Management, Population Trends for Washington State, 1998.

Employment. Selected employment data for the states of Oregon and Washington and the counties in those states that included in the study area for 1996 were examined to establish the relative importance of agriculture in the study area's economy as compared with the two states. The data examined are shown in Tables I-3 and I-4 for Oregon and Washington, respectively. Comparison of employment percentages by sector for each of the states and their respective counties in the study area shows that on the Oregon side of the river, in 1996 agriculture accounted for nearly three times as many jobs in the study area (8.3 percent of total employment) than in the state (2.9 percent). Manufacturing also accounted for a larger share of total employment in the study area (19.4 percent) than it did in the state (16 percent). It is of interest to note that in the study area, nearly two-thirds of all manufacturing jobs were in food processing compared with only about one-tenth for the state. The relatively large number of food processing jobs in the study area is due entirely to irrigated agriculture, of which land irrigated from the John Day Dam pool is a major component.

Table I-2. Population Projections for Oregon, Washington, and John Day Dam Study Area Counties

	1990	1995	2000	2005	2010	2000-10 Projections Total Growth	2000-10 Projections Annual % Growth
Study Area-Total	197,767	210,832	222,555	235,163	248,075	25,520	1.15%
Study Area-Oregon	68,591	72,444	76,302	80,281	84,090	7,788	1.02%
Study Area-Washington	129,176	138,388	146,253	154,882	163,985	17,732	1.21%
Oregon and Washington	7,708,984	8,415,766	8,968,807	8,862,077	10,017,989	1,049,182	1.17%
Oregon	**2,842,321**	**3,126,873**	**3,357,591**	**3,566,189**	**3,773,678**	416,087	1.24%
Gilliam	1,717	1,691	1,650	1,618	1,591	-59	-0.36%
Morrow	7,625	8,095	8,596	9,157	9,713	1,117	1.30%
Umatilla	59,249	62,658	66,056	69,506	72,786	6,730	1.02%
Hood River	16,903	18,022	19,146	20,347	21,580	2,434	1.27%
Sherman	1,918	1,848	1,764	1,685	1,615	-149	-0.84%
Wasco	21,683	23,728	25,160	26,762	28,445	3,285	1.31%
Washington	**4,866,692**	**5,429,887**	**5,849,893**	**6,291,772**	**6,693,325**	843,432	1.44%
Benton	112,560	130,998	146,020	155,320	163,037	17,017	1.17%
Klickitat	16,616	18,101	19,410	20,838	22,126	2,716	1.40%
Skamania	8,289	9,551	10,179	10,883	11,468	1,289	1.27%
Franklin	37,473	44,000	48,831	53,041	56,592	7,761	1.59%

On the north side of the river in Washington, jobs in agriculture and food processing in 1996 were somewhat less important to the economy of the study area in that state than it was in Oregon. Notwithstanding, jobs in agriculture accounted for 9.4 percent of all jobs compared with 3.7 percent for the state. The manufacturing sector accounted for just 8.7 percent of all jobs in the study area, compared with 14.1 percent for the state. Food processing, however, was still important and accounted for a much larger share of employment in the study area (12.2 percent) than in the state (1.8 percent).

b. Agricultural Profile

The history of irrigated agriculture on lands irrigated with water drawn from the John Day pool differs significantly from the history of irrigated agriculture in the west in general. Irrigated agriculture in the west in general is the result of an intentional and well-organized public and private enterprise. This enterprise was formalized and substantially boosted by the passage of the Reclamation Act of 1902. The Reclamation Act established the Federal interest in irrigation development in the west and led to Federal financing, planning, engineering and construction of major projects throughout the west through the actions of various Federal agencies, but principally the U.S. Bureau of Reclamation. The bureau is now the operator of more than 100 irrigation and multipurpose projects throughout the west.

In contrast, irrigation and associated municipal and industrial (M&I) water use from the John Day pool is a story of private initiative and Federally funded development of the Columbia River for navigation, hydropower generation and flood control. Prior to completion of construction of the John Day project in about 1968, there was little or no irrigation with water drawn from the Columbia River along the reach of the current John Day pool. However, with completion of the

Table I-3. John Day Dam Study Area County Employment by Sector for Oregon in 1996

Sector	State	Percent of Total	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco	Combined Counties	Percent of Total
Total Employment	1,466,126	100.0	748	9,410	3,153	633	24,654	8,986	47,584	100.0
Agriculture, For. and Fish.	42,897	2.9	13	1,387	450	29	1,904	908	4,691	9.9
Ag. Production - crops	22,729	1.6		1,092	291		1,226	837	3,446	7.2
Ag .production – livest.	2,333	0.2			100		174		274	0.6
Agricultural services	12,565	0.9		269	60		462	39	830	1.7
Mining	1,798	0.1							0	0.0
Construction	76,929	5.2	3	334	73		867	230	1,507	3.2
Manufacturing	234,868	16.0	19	1,268	857		4,662	1,142	7,948	16.7
Food and kindred prods.	25,910	1.8		171	646		2,831	300	3,948	8.3
Trans., Comm., and Utils.	69,930	4.8	278	513	195	30	1,042	175	2,233	4.7
Wholesale Trade	88,537	6.0	34	588	124	52	1,131	249	2,178	4.6
Retail Trade	274,701	18.7	105	1,604	224	207	4,376	2,175	8,691	18.3
Finance, Ins. and Real Estate	77,248	5.3	22	181	69	8	690	267	1,237	2.6
Services	373,710	25.5	82	2,033	358	41	4,994	1,906	9,414	19.8
Government	223,848	15.3	184	1,310	733	253	4,963	1,870	9,313	19.6
Nonclassifiable / all others	1,662	0.1	7	191	72	15	24	64	373	0.8

Source: 1996 Oregon Covered Employment and Payrolls. Oregon Employment Department, December 1997.

Table I-4. John Day Dam Study Area County Employment by Sector for Washington in 1996

Sector	State	Percent of Total	Benton	Franklin	Klickitat	Skamania	Combined Counties	Percent of Total
Total Employment	2,404,591	100.0	58,003	19,614	5,841	1,871	85,329	100.0
Agriculture, For. and Fish.	88,385	3.7	5,499	4,947	534	31	11,011	12.9
Ag production – crops	57,304	2.4		4,377			4,377	5.1
Ag production – livest.	5,541	0.2					0	0.0
Agricultural services	19,677	0.8		411			411	0.5
Mining	3,323	0.1	-	-	-		0	0.0
Construction	119,190	5.0	2,902	970	232	46	4,150	4.9
Manufacturing	339,274	14.1	4,150	1,487	1,418	260	7,315	8.6
Food Products */	37,886	1.6	1,687	1,258			2,945	3.5
Transport. and Public Utils.	117,990	4.9	3,408	736	334	29	4,507	5.3
Wholesale Trade	140,129	5.8	1,381	1,542	335		3,258	3.8
Retail Trade	437,424	18.2	9,837	2,489	601	187	13,114	15.4
Finance, Ins. and Real Estate	121,070	5.0	1,824	-		28	1,852	2.2
Services	611,748	25.4	19,559	3,454	618	477	24,108	28.3
Government	426,058	17.7	9,443	3,622	1,600	787	15,452	18.1
Nonclassifiable / all others	-	-	-	367	169	26	562	0.7

Source: Washington State Databook, 1999.

1/ Source: County Business Patterns, U.S. Bureau of Census, 1996.

project, ideal climate and soils along with water pumped from the John Day pool allowed for extensive agricultural development in the area.

The economic importance of agriculture is assessed in the report in the context of the five counties in Washington and Oregon that would be directly impacted by drawdown of the John Day pool. Parameters used for the assessment are (1) the number of farms; (2) acreage in farms; (3) the number of irrigated farms; (4) acreage in irrigated farms; and, (5) the market value of agricultural products sold. Data are presented for 1992 and 1997. In addition to the data for the five counties, data for the States are presented to establish the relative importance of the study area in its respective state. Data for Oregon are shown in Table I-5 and the data for Washington are shown in Table I-6. As shown in Table I-5, while the study area in Oregon accounts for only 9.5 percent of the number of farms, it accounts for 27.5 percent of the land in farms, 16.5 percent of the irrigated land and 18.8 percent of the market value of agricultural products sold. At the same time, the area accounts for only 2.4 percent of the state's population (Table I-1). On the north side of the river in Washington, a similar situation exists, but it is less pronounced. There the study area accounts for 8.7 percent of all farms, about 11.7 percent of the land in farms, 23.2 percent of the irrigated land, and 14 percent of the value of agricultural products sold (Table I-6). These data suggest a significant concentration of irrigated agriculture in the study area.

Agricultural Production Agricultural production for the study area was estimated based on a survey conducted by the Corps in 1995, supplemented by additional information from follow-up conversation with representatives of two of the farms in Oregon and with a representative of Potlatch Corporation. As shown in Tables I-7 and I-8, in 1994 there were a combined total of about 162.00 thousand acres in production (Oregon 89.70 thousand acres and Washington 72.30 thousand acres). The combined value of production (1994 reported and estimated production and average 1998 prices) amounts to a total of about $225 million (Oregon $111.2 million and Washington $119 million).

Table I-5. Selected Agricultural Data for John Day Dam Pool Counties in 1992 and 1997

Data Type	Year	State of Oregon	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco	Combined Counties	Percent of State
Number of Farms (all farms)	1997	34,030	166	537	420	168	1,488	470	3,249	9.5
	1992	31,892	143	563	378	179	1,441	456	3,160	9.9
Land in all Farms (acres)	1997	17,449,293	742,728	28,362	1,118,226	425,036	1,345,097	1,135,198	4,794,647	27.5
	1992	17,609,497	766,373	27,201	1,119,004	487,534	1,466,580	1,152,965	5,019,657	28.5
No. of Irrigated Farms	1997	15,348	29	496	223	24	940	260	1,972	12.8
	1992	15,002	26	533	200	24	919	277	1,979	13.2
Irrigated Land (acres)	1997	1,948,739	3,861	18,727	95,143	1,911	128,658	27,154	275,454	14.1
	1992	1,622,235	4,014	17,674	101,506	4,087	116,001	24,311	267,593	16.5
Market Value Product (Total Sales $1,000)	1997	2,969,194	24,526	63,306	141,531	23,937	249,201	56,987	559,488	18.8
	1992	2,292,973	17,036	54,921	94,132	20,585	186,690	48,743	422,107	18.4

Source: 1997 Census of Agriculture: Highlights of Agriculture: 1997 and 1992. www.nass.usda.gov/research/

Table I-6. Selected Agricultural Data for Washington John Day Dam Study Area Counties in 1992 and 1997

Data Type	Year	State of Washington	Benton	Klickitat	Franklin	Skamania	Combined Counties	Percent of State
Number of Farms (all farms)	1997	29,011	1,078	530	848	63	2,519	8.7
	1992	30,264	1,128	508	857	60	2,553	8.4
Land in all Farms (acres)	1997	15,179,710	611,903	588,732	563,716	4,220	1,768,571	11.7
	1992	15,726,007	640,370	689,639	670,149	4,063	2,004,221	12.7
No. of Irrigated Farms	1997	13,131	901	176	725	9	1,811	13.8
	1992	14,068	914	164	715	6	1,799	12.8
Irrigated Land (acres)	1997	1,705,025	153,254	20,239	221,145	272	394,910	23.2
	1992	1,641,437	134,698	29,739	214,748	(D)	379,185	23.1
Market Value Product (Total Sales $1,000)	1997	4,767,727	300,530	33,231	332,935	1,532	668,228	14.0
	1992	3,821,222	213,877	34,000	239,528	1,001	488,406	12.8

Source: 1997 Census of Agriculture: Highlights of Agriculture: 1997 and 1992. www.nass.usda.gov/research/

As shown in Table I-7, the order of importance of crops grown in the study area in Oregon in terms of acres of production is alfalfa, potatoes, all wheat, field and sweet corn. These four crops account for over 80 percent of the total acreage and value of production. The total value of production (1994 reported and estimated production and average 1998 prices) amounts to about $111 million. Although the total value includes the value of poplars (harvested for wood chips for pulp), harvest has not yet occurred. The value shown is based on estimates of yield and the average expected long-term price (estimated range is $50 to $100 per bone-dry ton).[2]

As shown in Table I-8, the order of importance of crops grown in the study area in Washington in terms of acres of production is potatoes (26 percent), field and sweet corn (34 percent), alfalfa (eight percent) and all wheat (seven percent). These four crops account for about 75 percent of the total acreage and 66 percent of the value of production. The total value of production (1994 reported and estimated production and average 1998 prices) amounts to about $119 million. As is the case with Oregon, although the total value includes the value of poplars (harvested for wood chips for pulp), harvest has not yet occurred. The value shown is based on estimates of yield and the average expected long-term price (estimated range is $50 to $100 per bone-dry ton).[3]

2. Based on information obtained from Potlatch Corporation, August 1999.
3. Based on information obtained from Potlatch Corporation, August 1999.

Table I-7. Irrigated Acres, Crops, Estimated Production and Market Value Impacted by John Day Dam Alternatives in Oregon

Crop Type	Acres	Yield/Acre	Production	Unit Value	Total Value ($)
Potatoes (tons)	18,741	26.6	498,784	104.00	51,873,500
All Wheat (bushels)	10,737	118.1	1,268,063	2.78	3,525,216
Field Corn (bushels)	11,600	178.8	2,073,411	2.53	5,245,729
Sweet Corn (tons)	6,177	9.6	58,990	148.40	8,754,168
Alfalfa (tons)	27,848	7.1	196,791	100.00	19,679,112
Alfalfa Seed (tons)	485	0.5	243	2,799.20	678,806
Grass Seed (lbs)	-	0	-	0.62	-
Hay and Pasture (aum)	6,010	6	36,060	14.00	504,840
Beans (tons)	1,759	18	31,662	144.90	4,587,824
Peas (tons)	1,259	21	26,439	216.52	5,724,572
Popcorn (tons)	779	3.1	2,415	104.99	253,539
Onions (tons)	1,240	15.9	19,654	250.00	4,913,500
Carrots (tons)	125	25.7	3,208	70.02	224,589
Milo (bu)	125	200	25,000	3.15	78,750
Canola (tons)	401	0.6	241	180.00	43,308
Poplars (tons)	64	8.2	524	75.00	39,273
Vineyards (tons)	-	2.94	-	774.37	-
Orchard (tons)	-			1,171.00	
Apples (tons)	580	13.1	7,598	632.00	4,801,936
Apricots (tons)	-		-	800.00	-
Cherries (tons)	-		-	1,710.00	-
Asparagus (tons)	-		-	1,020.00	-
Mint (lbs)	-	78	-	11.10	-
Sugar Beets (tons)	-		-	40.70	-
Landscape	11		-		-
Other Grass (hay) (tons)	1,800	2.3	4,140	82.50	341,550
Total	**89,741**				**111,270,212**

Notes:
1. Unit value source is Umatilla and Morrow County Crop Report--1998, Oregon Agricultural Extension Service.
2. Acres are reported by growers in COE 1995 survey and IRZ Engineering, August 1999.
3. Yield is average of yield reported by growers or Crop Report—1998.

Table I-8. Irrigated Acres, Crops, Estimated Production and Market Value Impacted by John Day Dam Alternatives in Washington

Crop Type	Acres	Yield/Acre	Production	Unit Value	Total Value
Potatoes (tons)	20,095	26.6	534,814	102.00	54,551,035
All Wheat (bushels)	5,477	118.1	646,834	2.78	1,798,198
Field Corn (bushels)	18,558	178.8	3,317,243	2.53	8,392,624
Sweet Corn (tons)	6,648	9.6	63,488	148.40	9,421,679
Alfalfa (tons)	7,908	7.1	55,883	100.00	5,588,320
Alfalfa Seed (lbs)	-	1,050.0	-	1.40	-
Grass Seed (lbs)	2,610	1,953.00	5,097,330	0.62	3,181,244
Hay and Pasture (aum)	108	2	216	14.00	3,024
Beans (tons)	-	18	-	144.90	-
Peas (tons)	20	21	420	216.52	90,938
Popcorn (tons)	-	3.1	-	104.99	-
Onions (tons)	2,548	15.9	40,386	250.00	10,096,450
Carrots (tons)	1,542	25.7	39,568	70.02	2,770,532
Milo (bu)	-	200	-	2.53	-
Canola (tons)	200	0.6	120	180.00	21,600
Poplars (tons)	2,700	8.2	22,091	75.00	1,656,818
Vineyards (tons)	2,131	2.94	6,265	774.37	4,851,536
Orchard (tons)	250	2.94	735	774.37	
Apples (tons)	840	13.1	11,004	1,171.00	12,885,684
Apricots (tons)	40	13.1	524	632.00	331,168
Cherries (tons)	60	1.5	90	1,710.00	153,900
Asparagus (tons)	20	1.9	38	1,020.00	38,760
Mint (lbs)	500	78	39,000	11.10	432,900
Sugar Beets (tons)	3,262	20	65,240	40.70	2,655,268
Landscape	-		-		-
Other Grass (hay) (tons)	745	2.3	1,714	82.50	141,364
Total	**76,262**				**119,063,041**

Notes: 1. Unit value source is Umatilla and Morrow County Crop Report--1998, Oregon Ag. Extension Service.
2. Acres are reported by growers in COE 1995 survey and IRZ Engineering, August 1999.
3. Yield is average of yield reported by growers or Crop Report—1998.

Source: Study.

II. POWER SYSTEM IMPACTS

1. Introduction

This section summarizes the possible regional impacts associated with the changes in hydropower production at John Day Dam. The changes in hydropower production for each of the study alternatives have been identified by a Corps document "Hydropower Write-up for John Day Drawdown Phase I Study." Tables II-1, II-2 and II-3, below, are taken from that study. Table II-1 compares the generation capacity and average output of the lower Snake and John Day facilities. Table II-2 shows the individual characteristics of several drawdown scenarios. Table II-3 shows the changes in system power generation under these drawdown scenarios.

According to Table II-1 the lower Snake River average annual energy output is 10.51 million megawatt-hours (MWh) or an average hourly output of 1.20 thousand average megawatt-hours (aMW), compared to John Day at 10.04 million MWh or 1.15 thousand aMW. Thus the annual output at John Day is about 96 percent of the output of the four lower Snake River dams combined.

Table II-1. Hydropower Plant Characteristics

	Ice Harbor	Lower Monumental	Little Goose	Lower Granite	Lower Snake Total	John Day
Number of Units	6	6	6	6	24	16
Capacity Per Unit (MW)	3 (90) 3 (111)	6 (135)	6 (135)	6 (135)		16 (135)
Total Nameplate Capacity (MW)	603	810	810	810	3,033	2,160
Overload Capacity (MW)	693	931	931	931	3,486	2,484
In-Service Date	1 (1961) 2 (1962) 3 (1975)	2 (1969) 1 (1970) 3 (1979)	3 (1970) 3 (1978)	3 (1975) 3 (1978)		16 (From 1968 to 1971)
Average Annual Energy (aMW) W/O Condition	219	335	317	329	1,200	1,146
Average Annual Energy (1,000 MWh) Base Condition	1,918	2,935	2,777	2,882	10,512	10,039
Plant Factor Base Condition	32 %	36 %	34 %	35 %	34%	46 %

Notes: 1. The alternatives scenarios being evaluated for this study are among those represented in Table II-2. "Alternatives 1 and 2," represent drawdown of John Day Dam to the Spillway Crest level with or without flood control capability. The inclusion or exclusion of flood control operation at John Day was not found to affect the average monthly hydropower generation as determined by the hydropower model. Consequently these two are grouped together and represented by JD2 in Table II-2. Similarly "Alternatives 3 and 4," drawdown of the John Day pool to Natural River level, are represented by scenario JD5. For reference, JD1 represents the base case, without project condition. Other power scenarios included in Table II-2 depict John Day drawdown scenarios with variants of the four lower Snake River projects, including different river levels at the four lower Snake River dams, and different combinations of upstream and downstream flow augmentation for fish passage.

2. Regional impacts for the lower Snake River options were estimated previously in the report "Regional Economic Impact Models for the Lower Snake River Juvenile Salmon Migration Feasibility Study – Executive Summary." The results for the lower Snake River drawdown are in addition to the estimates of John Day impacts.

Source: Study.

Table II-2. John Day Dam Alternatives and Power Scenarios

Study Alternatives	Power Scenarios	John Day Dam Pool Level			Lower Snake River Dams		Upper Snake Flow Augment. (kaf)	1995 BiOp Flow Augmentation	
		Existing	Spillway	Natural River	Natural River	MOP		Colum-bia	Snake
Current Condition	JD1	X				X	427	X	X
Alternatives 1 and 2	JD2		X			X	427	X	X
	JD3		X		X		427	X	X
	JD4		X		X		0	X	
Alternatives 3 and 4	JD5			X		X	427	X	X
	JD6			X	X		427	X	X
	JD7			X	X		0		

Source: Study.

2. Regional Economic Impact Estimates

The analysis below closely follows the discussion completed for the lower Snake River water management scenarios. The analysis addresses the effect of increased electric bills paid by household consumers in terms of change in disposable income, and the regional impact of a short-run increase in employment used to construct replacement power capacity.

System generation scenario JD5 in Table II-3 shows the effect of a John Day drawdown to natural river level to be a loss of 1.09 thousand aMW. This is about 87 percent of the 1.25 thousand aMW loss estimated for the drawdown of the four lower Snake River dams. For this analysis it is assumed that the loss of all John Day generating capacity by drawing down to natural river level results in 87 percent of the loss of generating capacity attributed to the drawdown of the four lower Snake River dams, or about 1.09 aMW. Partial drawdown to the spillway crest is assumed to result in a loss of 551 aMW, or about 51 percent of the impact of the drawdown to natural river level (Table II-3).

3. Potential Business Failures with Breaching

Increases in costs for electric power and transportation, changes in the availability of irrigated farm output,[4] and removal of the reservoirs and locks could cause business changes in energy and transport intensive industries or in industries requiring reservoirs or inputs from agriculture. While business failures are possible, a detailed analysis is beyond the scope of this study.

Table II-4 shows the amount of direct employment by region in industries with potential business failures due to breaching. Primary aluminum production is located in the Downriver Subregion

4. The effects of farm shut down because of reduced supplies of irrigation water for the irrigated agriculture sector are estimated in addition to the impact of adopting alternative methods to deliver water to irrigated farms.

Table II-3. John Day Power Scenario Results From the Hydro System Seasonal Regulation Model (HSSR)

11.1 System Power Generation under Alternative Drawdown Scenarios (Averaged Over 60 Water Years) (aMW)

Study Alternatives	Power Scenarios	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AVG.
Current Condition	JD1	11,948	9,186	9,347	11,111	13,117	16,858	15,016	13,598	16,070	18,203	18,361	14,309	13,930
John Day at Spillway Crest														
Alternatives														
1 and 2	JD2	11,532	8,891	9,055	10,773	12,607	16,372	14,435	12,946	15,192	17,308	17,623	13,787	13,380
	JD3	10,645	8,396	8,372	10,204	11,669	15,183	13,297	11,459	13,143	15,239	15,755	12,618	12,167
	JD4	10,572	8,464	8,429	10,304	11,641	15,329	13,440	11,482	13,038	15,284	15,778	12,481	12,189
John Day at Natural River Level														
Alternatives														
3 and 4	JD5	11,151	8,663	8,696	10,411	12,096	15,683	13,759	12,306	14,341	16,602	17,023	13,361	12,844
	JD6	10,244	8,211	8,155	9,804	11,186	14,337	12,555	10,753	12,297	14,584	15,101	12,059	11,609
	JD7	9,197	8,241	8,964	10,519	12,150	15,556	13,135	11,224	12,286	14,055	13,732	11,406	11,707

11.2 Change in System Power Generation Relative to Current Condition (JD1) (aMW)

Study Alternatives	Power Scenarios	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AVG.
Current Condition	JD1	-	-	-	-	-	-	-	-	-	-	-	-	-
John Day at Spillway Crest														
Alternatives														
1 and 2	JD2	-416	-295	-293	-338	-510	-486	-581	-652	-878	-894	-739	-522	-551
	JD3	-1,303	-790	-975	-908	-1,448	-1,675	-1,718	-2,138	-2,927	-2,963	-2,607	-1,691	-1,763
	JD4	1,375	-722	-919	-808	-1,476	-1,529	-1,576	-2,115	-3,032	-2,919	-2,583	-1,828	-1,741
John Day at Natural River Level														
Alternatives														
3 and 4	JD5	-797	-523	-651	-700	-1,021	-1,175	-1,257	-1,292	-1,729	-1,601	-1,338	-948	-1,086
	JD6	-1,704	-976	-1,192	-1,307	-1,931	-2,522	-2,461	-2,844	-3,773	-3,619	-3,260	-2,249	-2,321
	JD7	-2,751	-945	-383	-593	-967	-1,303	-1,881	-2,374	-3,784	-4,148	-4,629	-2,903	-2,224

Source: Study.

Table II-4. Estimated Direct Employment in Industries with Potential Business Failures due to Dam Breaching in 1994

Geographic Area	Primary Aluminum Mfg.	Food Processing (can./freez.)	Paper Mfg.	Grain Farms	Water Transport
Upriver Subregion	0	0	1,778	1,646	134
Reservoir Subregion	0	1,917	545	3,488	24
Downriver Subregion	1,159	5,388	100	6,180	27
TOTAL, LOWER SNAKE RIVER REGION	1,159	7,305	2,423	11,314	185
State of Washington	5,300	21,705	11,579	10,893	9,495
State of Oregon	930	13,265	5,234	7,828	2,195
State of Idaho	30	9,275	1,780	8,668	300

Note: The estimated direct employment excludes the multiplier effect on employment that would occur with business closures. For example, if one primary aluminum plant with 580 employees closed, aluminum exports from the Downriver Subregion would fall by an estimated $145 million (IMPLAN). The estimated direct, indirect, and induced effects on jobs in the Downriver Subregion would total 1,400 jobs (based on an employment multiplier of 9.66 jobs per million dollar expenditure) The direct employment loss of 580 jobs would be in the aluminum plant while the secondary effect on employment would create jobs losses of 820 jobs distributed across many sectors of the economy.
Source: IMPLAN (1994).

and throughout the Pacific Northwest. Breaching would cause power costs to rise for aluminum plants in Washington, Oregon, and Idaho. Food processing impacted by breaching is in the Downriver and Reservoir Subregions. Paper manufacturing that would be most affected by breaching is in the Upriver Subregion. Grain farms located in the Upriver Subregion and the eastern part of the Reservoir Subregion would be most affected by breaching. Water transport impacted by breaching, consisting of marinas, jet boats, tour boats, and marine cargo, is mainly in the Upriver Subregion.

4. Power Plants in the Impact Regions

An important short run economic impact is the expected construction of replacement capacity either within the subregions or within the States under study. The Upriver Subregion in central Idaho contains one power plant, the Dworshak hydroelectric plant operated by the U.S. Army Corps of Engineers. Power from this plant is marketed by Bonneville Power Administration. The plant capacity is 400 MW.

The Reservoir Subregion in southeast Washington contains four power plants on the lower Snake River. The plants are Ice Harbor (603 MW), Lower Monumental (810 MW), Little Goose (810 MW), and Lower Granite (810 MW) hydroelectric power plants operated by the U.S. Army Corps of Engineers. Power from these plants is marketed by Bonneville Power Administration. These four plants would be put out of operation if the lower Snake River dams were breached.

The Downriver Subregion contains four U.S. Army Corps of Engineers hydroelectric plants on the Columbia River: McNary (986 MW), John Day (2.16 thousand MW), Dalles (1.81 thousand MW), and Bonneville (1.08 thousand MW). Power from these four plants is marketed by Bonneville Power Administration.

Another important power plant in the Downriver Subregion is the coal-fired steam electric plant, located south of Boardman. The Boardman plant was placed in service in 1980. The plant is jointly owned by Portland General Electric, Pacific Northwest Gen. Co., and Idaho Power Company. Operating cost per MWHR is $17.06. Average employment at the plant in 1992 was 119. This plant has a capacity of 560 MW.

The Hermiston Generating Project consists of two 234.5 MW natural gas fired combined-cycle cogeneration plants. The Hermiston Generating Project was placed in service in 1996. The plant is located south of Hermiston, Oregon. Cogenerated steam is sold to Lamb-Weston, a potato processor. The plant is owned by U.S. Generating Company, an unregulated subsidiary of PG&E.

The Coyote Springs generating plant is also a natural gas fired combined-cycle cogeneration plant located at Boardman Industrial Park. Cogenerated steam is sold to Logan International, a potato processor. The Coyote Springs plant was placed in service in 1995. The plant is owned by Portland General Electric. The Coyote Springs plant could be expanded with a second unit. Portland General Electric has a site certificate.

One other power plant in the Downriver Subregion is the Washington Public Power Supply System (WPS-2) 1.17 thousand MW nuclear-fueled plant near Richland, Washington. (It is known that this plant is not operated at anywhere near its rated capacity, *UDI/McGraw-Hill Power Plant Performance Data*, Sept. 1993.) Operating cost per MWHR for this plant is very high relative to other plants in the Pacific Northwest at $30.76 per MWHR. Power from this plant also is marketed by Bonneville Power Administration. Employment at this plant totaled 1.40 thousand in 1992.

A new combined cycle power plant, Hermiston Power Project, is proposed by Hermiston Power Partners near Hermiston, Oregon. Hermiston Power Partners holds a site certificate. The 556 MW plant would be completed in 2001. The proposed plant is being developed by Ida-West Energy Company, a wholly-owned subsidiary of IDACORP and an affiliate of the Idaho Power Company, and by TransCanada Pipelines Limited. Cogenerated steam would be sold to Simplot for potato processing.

5. Direct, Indirect, and Induced Economic Effects of Possible Electric Rate Increases

John Day Dam generates a significant share of the region's power supply. Without this generating capacity the price of electricity to consumers would likely increase. Increased electric bills would reduce net income for industries and reduce disposable income for households in the region. The extent that businesses would leave the region or reduce output and employment in reaction to reduced net income is unknown. Some large industries may be able to pass part of the increased electric bill on to their customers while other price-taking industries, such as agriculture, likely could not. Consumers would pay increased electric bills reducing their disposable income and reducing consumer spending on other goods and services, especially in the short run. The geographic distribution of increases in electric bills might be determined by federal legislation and cannot be known in advance.

The method of collecting the increased electric bill is also unknown. If the increase were paid by electric rate increases it would cause customer substitution out of electricity and increase the demand for natural gas, propane, fuel oil and insulation. Over time, more efficient household, commercial and industrial electric appliances, machines and processes would be substituted for electricity use. The long run demand for electricity has been shown to be sensitive to price increases. As a result, increasing the price per kWh consumed would reduce the amount of electricity that needed to be produced and increase the demand for substitute products. However, if the increased electric bill were paid by increased fixed monthly charges, the substitution effects would be minimal because few customers would be willing to give up their electricity connection (except for those firms and farms that shut down or leave the region).

For illustrative purposes, it was assumed that the increased electric bill was proportional to the current electric consumption and was collected by a fixed monthly charge on all Pacific Northwest ratepayers. Table II-5 shows the dollar amounts collected from each State and each sector. The middle estimate of $267.76 million total increase in electric bill is used (Note: This is 87 percent of the direct impact identified in the lower Snake River study). The electric bill increase is assumed to be spread over a very large number of customers. Most of the increase is assumed to occur in the States of Washington (52.22 percent), Oregon (29.94 percent), Idaho (12.11 percent) and Montana (4.54 percent). The remainder (1.18 percent) is collected in the States of California, Nevada, and Wyoming. Based on current consumption, the commercial sector would pay 24.47 percent, the industrial sector (except aluminum mills) 24.93 percent, aluminum mills (14.12 percent), agriculture (irrigation pumping) 3.09 percent, the residential sector 32.52 percent and federal agencies 0.87 percent.

It was assumed that increased Federal costs would be spread over taxpayers throughout the U.S. so that impacts in the Pacific Northwest would be minimal. Increased electric bills to residential and farm irrigation customers are assumed to be paid by households and create a reduction in disposable income to households. The effect on individual households would be small (typical monthly household electric bills might rise a few dollars).

Table II-5. Annual Expenditure Increases by State and Sector (Million Dollars)

	State							
Sector	Wash.	Ore	Idaho	Mont	Cal	Nev	Wyom	Total
Commercial	34.32	21.65	7.39	1.55	0.39	0.06	0.12	65.48
Industrial	30.67	19.44	10.28	4.44	0.19	0.94	0.23	66.19
Irrigation	2.95	1.51	3.53	0.10	0.16	0.01	0.01	8.27
Residential	46.93	26.33	10.67	2.07	0.62	0.71	0.36	87.69
Aluminum	22.62	11.21	0.00	3.98	0.00	0.00	0.00	37.81
Federal	2.32	0.00	0.00	0.00	0.00	0.00	0.00	2.32
Total	139.81	80.14	31.87	12.14	1.36	1.72	0.72	267.76

Notes: 1. 1998 dollars.
2. Electricity bill increases shown here are estimated to be 87 percent of those shown in the lower Snake River Study, Regional Economic Impact Models for the Lower Snake River Juvenile Salmon Migration Feasibility Study, Agricultural Enterprises, Inc., for Foster Wheeler Environmental, Completion Report June 15, 1999

Source: Study.

The direct, indirect, and induced economic effects of reduced household income in the States of Washington, Oregon, Idaho, and Montana are estimated using input-output models for these four states.[5] Adopting alternatives 3 and 4 (represented by JD5 – breaching to natural river level) would create a significant change in household disposable income. Alternatives 1 and 2 (represented by JD2 – drawdown to spillway crest level) would result in about half (51 percent) of the impact of the natural river level alternative.

Under the breaching alternative, increased electric power bills paid by households would cause household personal income to fall by -$49.88 million in Washington (residential plus irrigation sectors). Using the Washington input-output multipliers; direct, indirect, and induced sales in the State would fall by -$117.07 million, Washington employment would fall by -646 jobs, and personal income would fall by an added -$18.32 million.

Under the breaching alternative, increased electric power bills paid by households would cause household personal income to fall by -$27.84 million in Oregon. Using the Oregon input-output multipliers; direct, indirect, and induced sales in the State would fall by -$70.05 million, Oregon employment would fall by -441 jobs, and personal income would fall by an added -$12.02 million.

Under the breaching alternative, increased electric power bills paid by households would cause household personal income to fall by -$14.21 million in Idaho. Using the Idaho input-output multipliers; direct, indirect, and induced sales in the State would fall by -$32.28 million, Idaho employment would fall by -216 jobs, and personal income would fall by an added -$5.13 million.

Under the breaching alternative, increased electric power bills paid by households would cause household personal income to fall by -$2.17 million in Montana. Using the Montana input-output multipliers; direct, indirect, and induced sales in the State would fall by -$4.58 million, Montana employment would fall by -31 jobs, and personal income would fall by an added -$530.00 thousand.

The economic impacts of increased electricity bills on the commercial, industrial, and aluminum sectors are unknown because information is not available to predict the effects of increased operating costs on production and employment. The aluminum processing sector could be severely impacted. Based on their share of current electricity use, aluminum mills in Washington would have an increased electricity bill of $22.62 million, while mills in Oregon would have an increase of $11.21 million, and mills in Montana would have an increase of $3.98 million (Table II-5).

Although the effects on the viability and operating levels of electricity-intensive firms and plants are unknown, the effects on the personal income of in-State ownership can be estimated. Data in Table II-5 show the projected increase of electricity bills for commercial and industrial firms. Based on ES-202 data, a rough estimate of in-State ownership for commercial and industrial firms is 50 percent and 30 percent respectively (precise estimates would require knowledge of

5. Although economic impacts are generally more correctly treated as marginal changes, in this study for simplicity (in order to be able to apply input-output multipliers) direct impacts to industry sales and household income are treated as average changes.

gas consumption by many individual industries). Thus, the commercial row of Table II-5 can be multiplied times 0.5 and the industrial row times 0.3 to find the increased electricity bills paid by in-State owners if John Day Dam was breached. These crude estimates of increased electricity bills to local owners of commercial and industrial establishments are treated as reductions in spendable personal income.

Under the breaching alternative, increased electric power bills paid for commercial and industrial use would cause household personal income to fall by -$26.36 million in Washington. Using the Washington input-output multipliers; direct, indirect, and induced sales in the State would fall by -$61.88 million, Washington employment would fall by -342 jobs, and personal income would fall by an added -$9.68 million.

Under the breaching alternative, increased electric power bills paid for commercial and industrial use would cause household personal income to fall by -$16.66 million in Oregon. Using the Oregon input-output multipliers; direct, indirect, and induced sales in the State would fall by -$41.92 million, Oregon employment would fall by -264 jobs, and personal income would fall by an added -$7.19 million.

Under the breaching alternative, increased electric power bills paid for commercial and industrial use would cause household personal income to fall by -$6.78 million in Idaho. Using the Idaho input-output multipliers; direct, indirect, and induced sales in the State would fall by -$15.41 million, Idaho employment would fall by -103 jobs, and personal income would fall by an added -$2.45 million.

Under the breaching alternative, increased electric power bills paid for commercial and industrial use would cause household personal income to fall by -$2.11 million in Montana. Using the Montana input-output multipliers; direct, indirect, and induced sales in the State would fall by -$4.45 million, Montana employment would fall by -30 jobs, and personal income would fall by an added -$520.00 thousand.

Note: In each case, the initial household income reduction was reduced by seven percent when calculating employment change for proper calibration of the 1994 input-output models. The impacts shown above are for the middle estimate of the change in electric bills. The effects of the low estimate can be found by dividing the results shown above by 1.28378. The effects of the high estimate can be found by multiplying the results shown above by 1.240557.

The impact of the drawdown to spillway crest (Alternatives 1 and 2 – represented by scenario JD2) is estimated by taking 51 percent of the breaching impact (scenario JD5).

6. Direct, Indirect, and Induced Economic Effects of Power Plant Construction

Breaching the John Day Dam would require replacement of an estimated 87 percent of the power lost from breaching the four lower Snake River dams, implying that 5.22 new power plants would be required. Therefore, it is assumed that six new power plants would be constructed to replace the John Day Dam power output. (Two of the six plants are needed to support system reliability.)

Each 250 mw gas-fired combined-cycle steam electric plant was assumed to take one year to construct; (memo from Ed Woodruff). The plant construction costs of ($601.00 thousand/MW)(250 MW) = $150 million are proposed to occur during the years 2007 (two plants), 2008, 2009, 2010 and 2016 (memo from Ed Woodruff).

In addition, a construction cost to modify electricity transmission lines of approximately $10 million is assumed to occur in 2008 (1998 purchasing power). The $10 million spent to modify power lines results in 241 jobs (direct, indirect, and induced) and $7.8 million (1994 dollars) $8.35 million (1998 dollars) of personal income (direct, indirect, and induced).

The construction cost to build a combined-cycle power plant is $150 million per plant (Corps). The Downriver Subregion utility construction multipliers are 2.2159, 0.00001987, and 0.6989 for sales, employment, and personal income respectively. Thus, the total sales created by the one-year construction projects for each plant would be $332.40 million. The total one-year employment effect for each plant would be 2.98 thousand /1.07 = 2.79 thousand jobs (adjusted to calibrate the 1994 IMPLAN model). The household sector would have an increase of $104.80 million personal income.

It assumed that these sales, employment, and personal income impacts would be doubled in the year 2007, in the Downriver Subregion, because two plants would be built simultaneously. A single plant would be built in the Downriver Subregion in 2008. The remaining three combined-cycle plants would be built somewhere in the Puget Sound area outside the Lower Snake River Subregion. Similar impacts can be expected when the plant construction occurs in the Puget Sound area.

7. Direct, Indirect, and Induced Economic Effects of Power Plant Operation

In order to measure the indirect and induced economic effects of operating the six new 250 mw gas-fired combined-cycle steam electric plants, they were considered to be an exogenous change of electricity output rather than an interdependent sector of the economy. According to BPA power system modeling, once new combined-cycle plants are constructed, they will operate at a 90 percent plant factor. The operating costs of the new plants were estimated at $13.61/MWh. The annual operating cost of each combined-cycle plant is (250MW)(0.90)(8.76 thousand hours per year)($13.61/MWh) = $26.8 million per year. The increase in annual final demand purchases of $161 million to operate the six new power plants was split 21 percent to labor (households) and labor-intensive services, and 79 percent to the natural gas production, transmission, and distribution sector based on information on combined-cycle plants.[6]

A total of three new combined-cycle plants would be constructed in the Lower Snake River Subregion. The first two plants would be constructed in 2007 and go on line in 2008. The first two plants are expected to be constructed in Hermiston and TriCities. It is estimated that a third plant would be built in 2008 in TriCities. Three more plants would be constructed in the Puget Sound region. A fourth plant would be built in 2009, a fifth plant in 2010, and a sixth plant in 2016. Annual spending increases in the Lower Snake River Subregion to operate the plants

6. The Standard Industrial Classification definition of the pipeline sector excludes natural gas transmission.

would be ($26.8 million)(2) = $53.6 million per year in 2008 and $80.4 million per year in 2009 and thereafter. Annual spending increases in the Puget Sound region would be $26.8 million per year in 2010, $53.6 million per year in 2011, and $80.4 million per year in 2017 and thereafter. Prior to the construction of the new gas-fired steam electric plants, the shortfall of power generated in the region would require electricity imports to the region. It is assumed that these electricity imports do not create any changes in spending or employment within the study region.

The operating costs are adjusted down by seven percent to match the 1994 calibration of IMPLAN. Both the Reservoir Subregion and Downriver Subregion are likely to impacted by the operation of the new combined-cycle power plants. Thus, the lower Snake River model was used to estimate impacts.

The sales multiplier for labor is 2.3695, the employment multiplier is 15.97 jobs/$million, and the personal income multiplier is 0.3692. Labor and labor-intensive services for the first two plants receives ($26.8 million)(2)(.21) = $11.26 million. Thus, operation labor and labor-intensive services for the first two plants would create some $26.70 million of direct, indirect and induced spending in the region. Operation labor and labor-intensive maintenance services for the first two plants would create some 179.76/1.07 = 168 jobs (adjusted to calibrate the 1994 IMPLAN model) in the region, starting in 2008. Operation labor and labor-intensive maintenance services for the first two plants would create some $4.16 million of personal income (direct, indirect, and induced) in the region, starting in 2008. Adding the third, equal sized, plant would increase these numbers by 1.5 times, starting in 2009 and thereafter. The remaining three combined-cycle power plants would add in a similar manner in the Puget Sound area in 2010, 2011 and 2017.

The major input to the combined-cycle generating plant is natural gas and that accounts for ($26.8 million)(2)(.79) = $42.34 million per year of purchases from the gas distribution sector for the first two combined-cycle generating plants. The multipliers for sales, employment, and personal income are 1.584, 0.0000105194, and 0.2730 respectively. Thus, the total (direct, indirect, and induced) added sales in the region created by the first two plant's gas purchases are $67.10 million per year (1998 dollars). The added employment from gas purchases to operate the first two plants (direct, indirect, and induced) is 445/1.07 = 416 jobs (adjusted to calibrate the 1994 IMPLAN model). The added personal income from gas purchases to operate the first two plants (direct, indirect, and induced) is $11.56 million per year. Adding the third, equal sized, plant would increase these numbers by 1.5 times, starting in the year 2009 and thereafter. The remaining three combined-cycle power plants would add to sales, income, and employment in a similar manner in the Puget Sound area in 2010, 2011 and 2017.

The region would lose 1.06 thousand jobs resulting from commercial and household consumption effects under the natural river alternative. In the short term, 2.91 thousand construction and related jobs would be added. As the power plants begin operation, a total of 299 long term jobs would be added to the region (Table II-6).

Table II-6. Employment Effects of Electric Power Modifications Due to John Day Dam Pool Water Management Alternatives

Natural River Drawdown Alternative (B1), Over 100 Years

Negative Job Impacts	Positive Job Impacts
100 90 80 70 60 50 40 30 20 10 0	0 10 20 30 40 50 60 70 80 90 100
2,073 jobs [Commercial and household consumption effects]	292 jobs [Power Plant Operation]
>----------<	>----------<
	3,027 jobs [Construction]
	>-----<

Spillway Crest Alternative (B2), Over 100 Years

Negative Job Impacts	Positive Job Impacts
100 90 80 70 60 50 40 30 20 10 0	0 10 20 30 40 50 60 70 80 90 100
1,057 jobs [Commercial and household consumption effects]	299 jobs [Power Plant Operation]
>----------<	>----------<
	2,906 jobs [Construction]
	>-----<

Source: Study.

III. TRANSPORTATION SYSTEM IMPACTS

1. Introduction

Two reports provide the basis for the regional transportation impact analysis. These are:

1. "Lower Snake River Juvenile Migration Feasibility Study – Transportation Study" by TransLog Associates. Prepared for The Research Group and U.S. Army corps of Engineers. August 15, 1999; and

2. "Draft" John Day Drawdown Phase I Study. Navigation. U.S. Army Corps of Engineers. October 20, 1999.

The Navigation Study can be summarized as follows:

- Drawdown to natural river level with or without flood control will probably see a nearly 100 percent switch from shipment by barge to shipment by rail.
- If the shipment of wheat and other commodities were to continue under drawdown conditions, major changes in collection and distribution would have to occur. The overall cost of upgrading infrastructure is assumed to be incorporated into the cost of shipping the goods themselves.

The following components will therefore be considered for modeling the regional impact of the proposed changes in the John Day system. The first impact is a reduction in the annual household income of some producers that utilize the Columbia River system due to higher costs of alternative means to transport goods. The second impact is an increase in income of individuals directly or indirectly involved in the construction of rail transport facilities. For modeling purposes the reduction in personal income resulting from reduced household expenditures is treated as a recurring (annual) event, while construction upgrades of the regional railroad facilities are assumed to be completed in equal parts over a ten-year period.

TransLog Associates expected no changes in rail rates or shifts in market shares resulting from changes in the lower Snake system dams. This was mainly due to assumed competition between barge, road and rail modes of transport. The bulk of North Dakota and Montana grain is currently shipped by rail to Pacific Northwest ports. Only a small portion of the grain is used as backhaul for other commodity shipments such as lumber. Therefore no significant change in cost (and therefore rates) was expected for long distance shipping of grain. For the local grain market (Washington, Idaho and Oregon), some increase in costs and therefore rates resulting from the shift to trucking to the Tri-Cities area rather than to Lewiston may be expected. TransLog estimated the weighted average cost difference between shipping via the two modes to Portland terminals (combination truck/barge vs. rail) to be about $1.75 per ton or about $0.053 per bushel (Table III-1). The assumption is that the railroads, absent of direct barge competition, would increase their rates to equal the cost increase.

The four-year average for goods loaded and unloaded between John Day Dam and Ice Harbor Dam is 5.97 million tons. Another 3.99 million tons is loaded and unloaded above Ice Harbor, of

Table III-1. Comparison of Alternative Truck-Barge Costs (Rates) and Alternative Rail Rates From Selected Representative Origins by County for Zero Percent Backhaul

	County	Alternate Major River Elevator Destination	County's Percent of Snake River Grain Facilities Draw**	Alternate Truck Costs to River Elevator	Alternate Barge Rates	Alternate* Truck/ Barge Distribution Costs	Alternate Rail Rates	Alternate Truck/ Barge Vs. Alternate Rail Difference
Washington								
1	Adams	Tri-Cities	7%	5.98	4.92	12.23	14.90	-2.67
2	Asotin	Tri-Cities	2%	10.29	4.92	16.54	20.80	-4.26
3	Columbia	Tri-Cities	4%	4.61	4.92	10.86	14.68	-3.82
4	Franklin	Burbank	1%	1.89	4.92	8.14	11.38	-3.24
5	Garfield	Tri-Cities	11%	6.43	4.92	12.68	15.83	-3.15
6	Grant	Kennewick	0%	7.03	4.91	13.27	12.58	0.69
7	Lincoln	Burbank	2%	9.38	4.92	15.63	15.86	-0.23
8	Spokane	Tri-Cities	8%	9.30	4.92	15.55	15.95	-0.40
9	Walla	Tri-Cities	7%	2.57	4.92	8.82	10.67	-1.85
10	Whitman	Tri-Cities	28%	8.85	4.92	15.1	16.03	-0.93
Idaho								
1	Bennewah	Tri-Cities	1%	14.60	4.92	20.85	20.87	-0.02
2	Boundary	Tri-Cities	3%	18.46	4.92	24.71	18.35	6.36
3	Idaho	Tri-Cities	5%	15.20	4.92	21.45	22.63	-1.18
4	Canyon	Hague Warner	1%	18.53	4.76	24.62		
5	Kootenai	Tri-Cities	5%	13.09	4.92	19.34	16.26	3.08
6	Latah	Tri-Cities	1%	12.63	4.92	18.88	21.05	-2.17
7	Lewis	Tri-Cities	0%	11.42	4.92	17.67	22.20	-4.53
8	Nez Perce	Tri-Cities	1%	10.89	4.92	17.14	21.65	-4.51
Oregon								
					4.92		18.66	
1	Wallowa	Tri-Cities	1%	11.64	4.92	17.89	18.14	-0.25

Note: *Includes a handling charge of $1.33/ton for the extra handle at the river elevator.
**Source: *Snake River-Navigation*, pp. 56-58.
Source: TransLog Associates (1999).

which 118.00 thousand tons are petroleum and related products, for a total of 9.95 million tons being shipped through this section of river. This includes 2.85 million tons of petroleum products. Since pipelines are an alternative means for shipping petroleum, it is assumed that the railroads will not raise rates for shipping petroleum products, but will raise rates by $1.75 for all other products in order to meet their existing cost structure. The impact of the change to rail transport is therefore modeled as a reduction in barge industry revenues and an increase in railroad transport and construction activity. A proposal to construct a 230 mile petroleum products pipeline from the Bellingham area to the Tri-Cities area was analyzed in 1998 and temporarily withdrawn.[7] This $103 million project was designed to deliver petroleum products to the Tri-Cities area for $1.50 per barrel, or about $9 per ton. The competitive challenge is

7. Washington State Energy Facility Site Evaluation Council (1998).

therefore present for the railroads. Further analysis for intermodal changes should take place in further analysis of changes in the John Day Dam pool water management alternatives. Especially important to agriculture in eastern Washington would be the expected fuel delivery cost assumptions along the pipeline, such as Royal City. There could be a reduction in total delivery cost since truck destination costs of fuel may be reduced.

If railroads charge $14.18 per ton (current truck/barge rate) for petroleum products and $15.93 per ton (current rail rate) for other cargo including grain, then the total additional revenues to the railroad industry is estimated to be: $111.13 million (farm and other products) + $42.03 million (petroleum products) = $153.16 million. The expectation is that existing railroad facilities would probably be sufficient to carry the additional freight.[8] Any infrastructure improvements completed for aggregation and offloading may be borne by the railroads or the grain trading companies. The constructions impacts are assumed to be part of the railroad expenditures.

2. Impacts of New Construction for Rail Transport

Railroad improvements and the construction impacts on sales, employment, and personal income are expected to continue as part of general railroad expenditures. The higher level of revenues will lead to a great amount of spending on maintenance and planned capital improvements. These are modeled as part of the railroad annual expenditures. There may also be some infrastructure improvements required for collection and transfer operations. These have not been identified or modeled in this study phase.

3. Impacts of Termination of Barge Operations

The barge industry is projected to have a loss of sales of $48.97 million. Spending by the barge industry is mainly in Portland, not in the Downriver Subregion. State of Oregon multipliers are therefore applied to find the impacts on the Oregon economy.

The sales multiplier for water transport in the Oregon model is 2.434, the employment multiplier is 16.57 jobs/$million, and the personal income multiplier is 0.5142. The direct, indirect, and induced effects on sales is -$119.17 million. The employment effect is -824/1.07 = -770 jobs (adjusted to calibrate the 1994 IMPLAN model). The effect on personal income is -$25.18 million.

4. Impacts of Increased Railroad Operations

If John Day Dam is breached, railroads are projected to have sales increases of $153.16 million per year. All revenues are assumed to be spent on general operations. The sales multiplier for railroads in the Downriver Subregion model is 2.261, the employment multiplier is 16.29 jobs/$million, and the personal income multiplier is 0.2614. The impacts (direct, indirect, and induced effects) of railroad operations would be $346.35 million increase in sales, 3.33 thousand increase in jobs, and $40.03 million increase in personal income, compared with existing levels without breaching of John Day Dam.

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8. TransLog Associates personal communication November 1999.

5. Impacts of Decreased Trucking Operations

The trucking industry is projected to have a decrease in sales of -$77.53 million if the John Day Dam is breached. The sales multiplier for trucking in the Downriver Subregion model is 2.360, the employment multiplier is 23.67 jobs/$million, and the personal income multiplier is 0.5578. The direct, indirect, and induced effects on sales is -$183.01 million. The employment effect is -1.83 thousand / 1.07 = -1.71 thousand jobs (adjusted to calibrate the 1994 IMPLAN model). The effect on personal income is -$43.25 million.

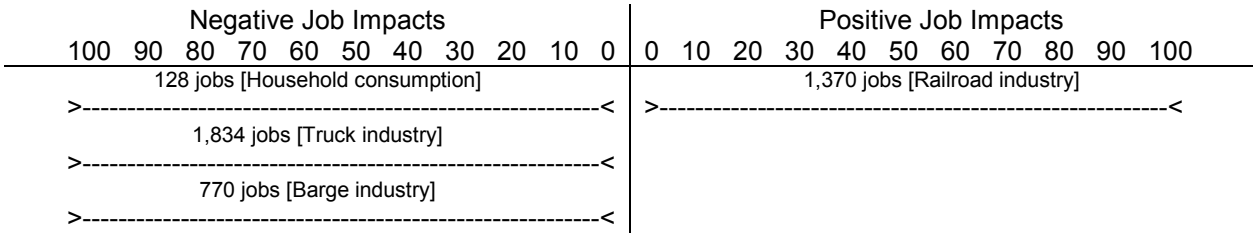
6. Effect of Increased Transport Cost on Farm Household Income and Spending

The $12.23 million that is added to the transport costs of agricultural producers is treated as a reduction in their disposable income (Note: While it is also possible that increased transport costs could significantly affect the viability of certain individual farms, this aspect was not specifically addressed). The Downriver Subregion sales multiplier for households is 1.955. The direct, indirect, and induced decrease in sales because of the drop in farm household income is = -$23.91 million. Applying the Downriver Subregion household employment multiplier (11.17 jobs/$million) to the reduction in farm household income results in a loss of -137/1.07 = -128 jobs (adjusted to calibrate the 1994 IMPLAN model). The Downriver Subregion personal income multiplier for households is 0.2614. The additional direct, indirect, and induced reduction in personal income is -$3.20 million. Thus, the total decline in personal income is -($12.23 million + $3.20 million) = -$15.43 million.

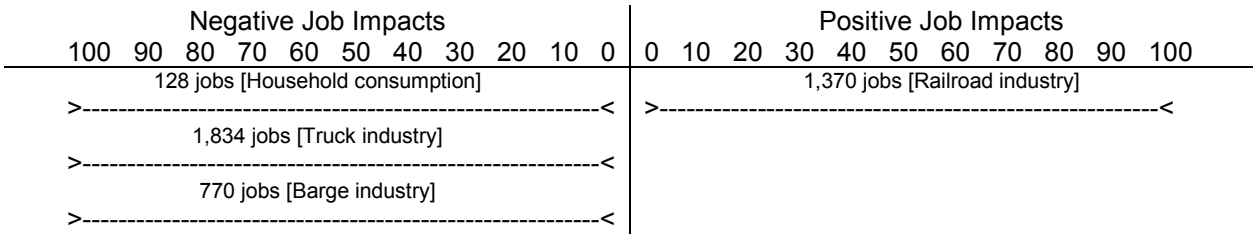
Under the natural river alternative, the region may lose 2.73 thousand long term jobs, mostly in the trucking, barging, and supporting industries (Table III-2). The railroads and supporting industries may gain a total of 1.38 thousand long term jobs in the region.

Table III-2. Employment Effects of Transportation Modification Due to John Day Dam Pool Water Management Alternatives

Natural River Drawdown Alternative (B1), Over 100 Years



Spillway Crest Alternative (B2), Over 100 Years



Source: Study.

IV. WATER SUPPLY IMPACTS

1. Irrigation Systems and Irrigated Agriculture

Dam breaching requires a $375 million investment in canals if irrigated agriculture is to continue as before. (See "John Day Drawdown Study: Economic Analysis of Impacts on Irrigation and M&I Water Supply"). If the cost of building the new canals is deemed prohibitive, irrigated agriculture would be terminated under the breaching alternative. The dry lands surrounding the reservoirs would be unproductive without irrigation and agricultural output would cease. This eventuality is scenario one. Scenario two analyzes the impacts of building the canals and paying the added irrigation costs with irrigated agriculture output maintained as it was before the breaching.

2. Water Supply Scenario One, Shutdown of Irrigated Agriculture

Table IV-1 shows the annual value of irrigated agricultural output in Washington and Oregon by irrigated crop type. Table IV-2 shows the Downriver Subregion sales, employment, and personal income multipliers appropriate for each irrigated crop. Table IV-3 shows the direct, indirect, and induced effects on sales, jobs, and personal income of terminating output for each irrigated crop.

The column sums of Table IV-3 show the direct, indirect, and induced economic effects of irrigation shutdown because of breaching. Termination of irrigated agriculture because of breaching creates a reduction of sales in the Downriver Subregion of -$910.2 million. Table IV-3 also shows that shutdown of irrigated agriculture because of breaching reduces employment in the Downriver Subregion by -9.28 thousand jobs (includes both part and full-time jobs). Table IV-3 shows that shutdown of irrigated agriculture because of breaching reduces personal income by -$350.5 million in the Downriver Subregion.

3. Water Supply Scenario Two, Construction of New Irrigation Canals

a. Effect of Increased Irrigation Water Cost on Farm Household Income and Spending

Under scenario two, an estimated $24.57 million per year is added to the irrigation costs of agricultural producers. With revenues expected to stay the same, the reduction is assumed to be in the bottom line of an agricultural enterprise. This is net profit or reduction in proprietor's income. This is analyzed as a reduction in their disposable income. The Downriver Subregion sales multiplier for households is 1.955. The direct, indirect, and induced decrease in sales because of the drop in farm household income is (1.955)(-$24.57 million) = -$48.03 million. Applying the Downriver Subregion household employment multiplier (11.17 jobs/$million) to the reduction of -$24.57 million in farm household income results in a loss of -274.56/1.07 = -257 jobs (adjusted to calibrate the 1994 IMPLAN model). The Downriver Subregion personal income multiplier for households is 0.2614. The additional direct, indirect, and induced reduction in personal income is (0.2614)(-$24.57 million) = -$6.42 million. Thus, the total decline in personal income is -($24.57 million + 6.42 million) = -$30.99 million.

Table IV-1. Value of Irrigated Agriculture Production Terminated by Breaching (Dollars)

Crop Type	Located in the State of Washington	Located in the State of Oregon	Total
Potatoes	$59,980,350	$51,873,500	$111,853,850
All Wheat	1,798,198	3,525,216	5,323,414
Field Corn	8,392,624	5,245,729	13,638,353
Sweet Corn	9,421,679	8,754,168	18,175,847
Alfalfa	5,588,320	19,679,112	25,267,432
Alfalfa Seed	0	678,806	678,806
Grass Seed	3,181,244	0	3,181,244
Hay and Pasture	3,024	504,840	507,864
Beans	5,216,400	4,587,824	9,804,224
Peas	9,184,778	5,724,572	14,909,350
Popcorn	0	253,539	253,539
Onions	20,398,950	4,913,500	25,312,450
Carrots	7,441,986	224,589	7,666,575
Milo	0	78,750	78,750
Canola	21,600	43,308	64,908
Poplars	1,656,818	39,273	1,696,091
Vineyards	7,583,514	0	7,583,514
Apples	69,644,054	4,801,936	74,445,990
Apricots	331,168	0	331,168
Cherries	153,900	0	153,900
Asparagus	38,760	0	38,760
Mint	432,900	0	432,900
Sugar Beets	2,655,268	0	2,655,268
Other Grass Hay	141,364	341,550	482,914
TOTAL	$213,266,899	$111,270,212	$324,537,111

Source: Study.

b. Effect of Increased Water Cost on Municipal and Industrial Users

An estimated $4.00 million per year is added to the water supply costs for municipal and industrial users. This is likely to result in increased water bills or taxes for residential, commercial, and industrial water users. No information is available on the distribution of water bills among these users. We assume that one quarter of the increase is borne by firms located outside the region leaving $3.00 million to be paid by local households and business owners.

The $3.00 million per year that is added to the water bill to local households and business owners is treated as a reduction in their disposable income. The Downriver Subregion sales multiplier for households is 1.955. The direct, indirect, and induced decrease in sales because of the drop in household income is (1.955)(-$3.00 million) = -$5.86 million. Applying the Downriver Subregion household employment multiplier (11.17 jobs/$million) to the reduction of -$3.00 million in household income results in a loss of -33.52/1.07 = -31 jobs (adjusted to calibrate the 1994 IMPLAN model). The Downriver Subregion personal income multiplier for households is 0.2614. The additional direct, indirect, and induced reduction in personal income is (0.2614)(-$3.00 million) = -$784.14 thousand. Thus, the total decline in personal income is -($3.00 million + 784.14 thousand) = -$3.78 million.

Table IV-2. Multipliers for Irrigated Crops in the Downriver Subregion

Crop Type	Sales Multiplier	Employment Multiplier (jobs/$million)	Personal Income Multiplier
Potatoes	2.8824	20.962	1.1695
All Wheat	2.5007	32.716	0.8211
Field Corn	2.5467	22.596	0.9099
Sweet Corn	2.8824	20.962	1.1695
Alfalfa	2.6359	54.254	0.9768
Alfalfa Seed	2.8832	35.058	1.1898
Grass Seed	2.8832	35.058	1.1898
Hay and Pasture	2.6359	54.254	0.9768
Beans	2.8824	20.962	1.1695
Peas	2.8824	20.962	1.1695
Popcorn	2.8824	20.962	1.1695
Onions	2.8824	20.962	1.1695
Carrots	2.8824	20.962	1.1695
Milo	2.5467	22.596	0.9099
Canola	2.8832	35.058	1.1898
Poplars	2.8832	35.058	1.1898
Vineyards	2.7349	38.244	0.9429
Apples	2.7349	38.244	0.9429
Apricots	2.7349	38.244	0.9429
Cherries	2.7349	38.244	0.9429
Asparagus	2.8824	20.962	1.1695
Mint	2.8824	35.058	1.1695
Sugar Beets	2.8824	20.962	1.1695
Other Grass Hay	2.6359	54.254	0.9768

Source: Study.

c. Effect of Increased Local Government Spending on Water Supply Infrastructure

Increased local government spending of $4.00 million occurs in the Downriver Subregion. Local government has a sales multiplier of 2.353, an employment multiplier of 0.0000162, and a personal income multiplier of 0.2614. Thus, sales in the Downriver Subregion would increase by ($4.00 million)(2.353) = $9.41 million; jobs would increase by ($4.00 million)(.0000162) = 64.8/1.07 = 61 jobs (adjusted to calibrate the 1994 IMPLAN model); and personal income would increase by ($4.00 million)(0.2614) = $1.05 million.

d. Effect of New Construction for Water Systems and Canals

Constructing new canals to replace irrigation water currently pumped from John Day pool is estimated to cost $375.00 million in the Downriver Subregion and construction costs are spread equally over a five-year period, i.e. $75.00 million per year. An additional one-time, one-year amount of $12.60 million is spent in the Downriver Subregion to modify water systems for municipal and industrial use. Maximum total new construction is thus $87.60 million in the first year and then $75.00 million for an additional four years. It was assumed these projects were funded with external resources. The new utility construction sales multiplier is 2.216, the employment multiplier is 19.87 jobs/$million, and the personal income multiplier is 0.6989.

Table IV-3. Direct, Indirect, and Induced Effects if Irrigated Agricultural Production is Terminated by Breaching

Crop Type	Loss of Sales (Dollars)	Loss of Employment (Part and Full-Time Jobs)	Loss of Personal Income (Dollars)
Potatoes	322,407,537	2,345	130,813,078
All Wheat	13,312,261	174	4,371,055
Field Corn	34,732,794	308	12,409,537
Sweet Corn	52,390,061	381	21,256,653
Alfalfa	66,602,424	1,371	24,681,228
Alfalfa Seed	1,957,133	24	807,643
Grass Seed	9,172,163	112	3,785,044
Hay and Pasture	1,338,679	28	496,082
Beans	28,259,695	206	11,466,040
Peas	42,974,710	313	17,436,485
Popcorn	730,801	5	296,514
Onions	72,960,606	531	29,602,910
Carrots	22,098,136	161	8,966,059
Milo	200,553	2	71,655
Canola	187,143	2	77,228
Poplars	4,890,170	59	2,018,009
Vineyards	20,740,152	290	7,150,495
Apples	203,602,338	2,847	70,195,124
Apricots	905,711	13	312,258
Cherries	420,901	6	145,112
Asparagus	111,722	1	45,330
Mint	1,247,791	15	506,277
Sugar Beets	7,653,544	56	3,105,336
Other Grass Hay	1,272,913	26	471,710
TOTAL	910,169,938	9,276	350,486,857

Source: Study.

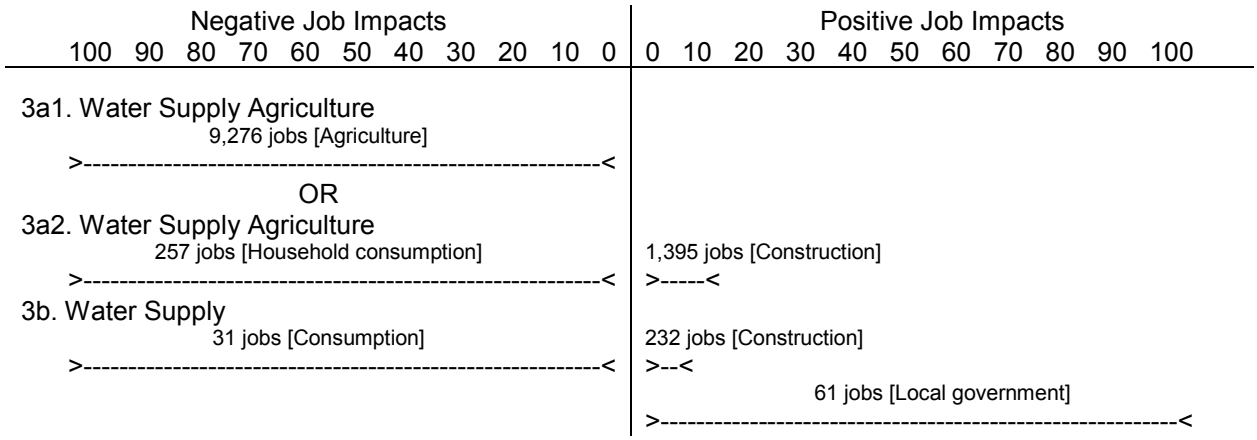
Thus, in the first year annual sales in the Downriver Subregion would increase by $87.60 million * 2.216 = $194.11 million; employment would increase by $87.60 million * 0.00001987 = 1.74 thousand / 1.07 = 1.63 thousand jobs (adjusted to calibrate the 1994 IMPLAN model); and annual personal income would increase by $87.60 million * 0.6989 = $61.22 million.

For an additional four years the increases from the baseline levels would be $166.19 million in sales, 1.39 thousand jobs and $52.42 million in personal income.

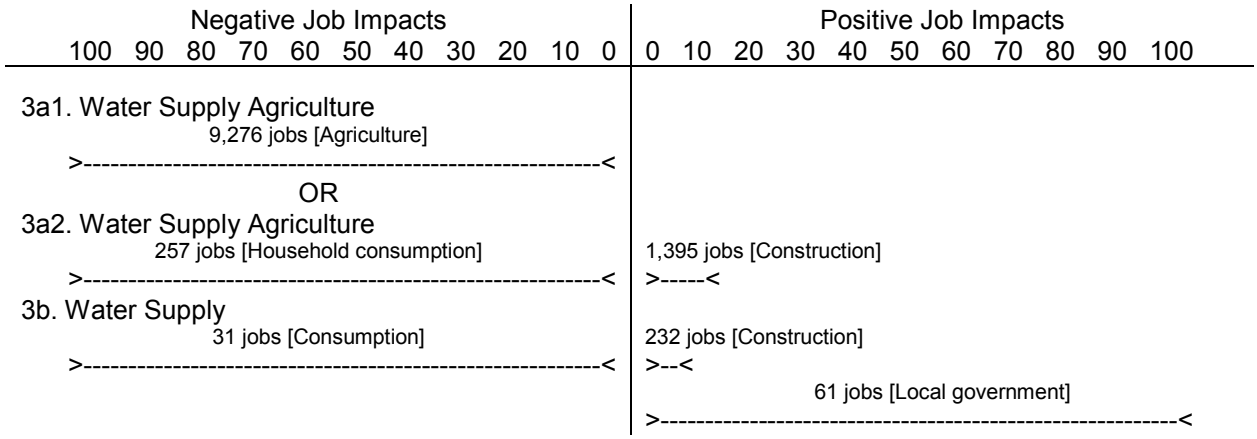
If farm production were to cease as a result of John Day Dam pool water management modifications, a total of 9.28 thousand jobs in agriculture and supporting industries may be lost to the region (Table IV-4). An additional 31 jobs may be lost due to consumption effects of higher water municipal, etc. rates. Local government spending may add a total of 61 jobs. Construction and related jobs may be added in the short run both for water supply construction and canal construction.

Table IV-4. Employment Effects of Water Supply Modifications Due to John Day Dam Pool Water Management Alternatives (Two Scenarios)

Scenario 1, No Irrigated Agriculture
Natural River Drawdown Alternative (B1), Over 100 Years



Scenario 2, Canal Construction for Agriculture
Spillway Crest Alternative (B2), Over 100 Years



Source: Study.

V. IMPACTS ON ANADROMOUS FISH

1. Introduction

The John Day Dam alternatives evaluated are shown in Table V-1. The two main alternatives are restore the pool area to natural river (referenced as Action B1) and lower the pool behind the Dam to spillway crest (referenced as Action B2). Under the natural river alternative, the pool elevation is taken to the level of The Dalles Dam pool at the John Day Dam tailrace. The second alternative draws the pool down to the crest of the John Day Dam spillway. A third alternative (referenced as Action B3) is for using flood control facilities for the natural river alternative. The alternatives are modeled with the assumption that the lower Snake River dams are being breached in tandem with modifications being made to the John Day Dam. The existing situation, or "base case," is for the John Day Dam and the lower Snake River dams to remain as they currently operate (referenced as Action A1).

Table V-1. Alternative Water Flow Management Actions Evaluated

Action Identifier	Action Description
A1	John Day Dam and lower Snake River dams as currently operated
B1	Natural river drawdown of four lower Snake River dams and John Day drawdown to natural level
B2	Natural river drawdown of four lower Snake River dams and John Day drawdown to spillway crest
B3	Natural river drawdown of four lower Snake River dams and John Day drawdown to natural river with flood control facilities

Source: Study.

The economic analysis evaluates all major anadromous fish stocks affected by altering the John Day Dam. This includes wild stocks, natural stocks, and hatchery stocks originating upstream of the John Day Dam in the Columbia River Basin.[9] The major anadromous fish stocks are defined to be spring/summer and fall chinook salmon *(Oncorhynchus tshawytscha),* and winter and summer steelhead *(O. mykiss)*. Other anadromous fish, such as shad *(Alosa sapidissima)*, sturgeon *(Acipenser transmontanus* and *A. medirostris)*, coho salmon *(O. kisutch)*, sockeye salmon *(O. nerka)*, etc., would not have fisheries significantly changed by the hydrosystem actions. All utilization of both wild and hatchery originating stocks was considered. This

9. Anadromous fish stocks originating from spawning habitat can be designated as "wild" and "natural" demes or stocks. Wild stocks have genetic makeup unlikely to have been altered by hatchery fish. Natural stocks are naturally spawning fish that have genetically mixed with hatchery fish. For example in the Snake River Basin, 23 natural and wild spring chinook and nine summer chinook stocks were identified by Chapman et al. (1991). Stocks of hatchery origin include 12 spring chinook stocks and two summer chinook stocks. One natural population of fall chinook has been identified. Since effects from altering the hydrosystem cannot be differentiated between wild and natural stocks, this report refers to both types as wild stocks.

includes commercial and recreational harvests, as well as sales of hatchery egg, carcass, and surplus fish.

2. Economic Valuation Methodology

The economic valuation of changed anadromous fish stock harvests relies on available methods and data. The economic values are based on input/output (I/O) models that translate direct fishing expenditures and hatchery costs into total personal income. The I/O models have been constructed for the Pacific Northwest states and Alaska with the use of the IMPLAN model.[10] An I/O model for British Columbia is from Radtke (May 1997). On the commercial side, representative budgets from the fish harvesting sector and the fish processing sector, as well as a price and cost structure for processing are used to estimate the impacts of changes. On the recreational side, a charter operator budget and recreational fishermen destination expenditures provide the basic data. Hatchery costs are proxied using sales of hatchery surpluses. The individual expenditure categories are used as I/O model inputs to estimate the total community income impacts. Regional economic impacts correspond to Regional Economic Development (RED) benefits used as an accounting stance by the Corps. Estimates of RED benefits for anadromous fish harvesting are based on a per fish value for commercial fishing, and per angler day value for recreational fishing. These unit values and recreational success rates by fisheries are shown in Table V-2. A more detailed explanation of assumptions and methods used to derive these values is presented in an appendix to the study element "Economic Evaluation of Changed Anadromous Fish Harvests Due to John Day Dam Hydrosystem Actions."

3. Harvest Distribution Assumptions

The forecast of fish available for harvest in the ocean and in-river is distributed to user groups within constraints of international understandings and Columbia River tribal treaty agreements. Historical harvest distribution patterns were used as a base and then modified for future expected management regimes.

There are a host of salmon treaties and agreements that affect salmon of the Columbia River system. These can be categorized as *international understandings*, such as the 1992 International North Pacific Fisheries Commission Convention (Shepard and Argue 1998), the United Nations Convention on the Law of the Sea which entered into force in November 1994, the PST between the United States and Canada, *harvest management agreement processes* such as the Pacific Fishery Management Council (PFMC), *agreements to rebuild the stocks* such as the Northwest Power Planning Act, *court decisions* that have defined the obligations to Northwest Indian Tribes, and most recently *federal mandates to protect salmon* stocks under the ESA. The forecast of future anadromous fish run sizes produced from the Snake River and the entire Columbia River system used in this study has taken into consideration the international

10. The commercial fisheries regional economic impact analysis used methods from Hans Radtke and William Jensen, who developed a fisheries economic assessment model (FEAM) for the West Coast Fisheries Development Foundation. The analysis of regional economic impacts for ocean recreational charter boats and ocean recreational private boat fishermen are based on the same methods used by the Pacific Fishery Management Council and are documented in annual reports about the Review of Ocean Salmon Fisheries. Analysis methods used to evaluate the inriver recreational fisheries are described by The Research Group (1991).

Table V-2. Economic Assumptions

Species/Fishery	Economic Impacts		Success Rates
	Commercial	Recreational	Recreational
Spring/Summer Chinook			
Ocean			
Alaska	69.15		
British Columbia	69.99		
Washington ocean	48.31		
Washington Puget Sound	41.22		
Oregon	42.05		
California	53.80		
Columbia Basin inland			
Mainstem	98.59	60.00	3
Tributary		60.00	5
Other	0.00		
Food Fish	49.12		
Carcass and egg sales	2.00		
Fall Chinook			
Ocean			
Alaska	69.15	60.00	1
British Columbia	69.99	60.00	1
Washington ocean	48.31	60.00	1
Washington Puget Sound	41.22	60.00	1
Oregon	42.05	60.00	1
California	53.80	60.00	1
Columbia Basin inland			
Mainstem	41.22	60.00	3
Tributary			
Other	0.00		
Food Fish	29.75		
Carcass and egg sales	2.00		
Summer Steelhead			
Ocean			
Alaska			
British Columbia	22.28		
Washington ocean			
Washington Puget Sound			
Oregon			
California			
Columbia Basin inland			
Mainstem	16.89	60.00	3
Tributary		60.00	5
Other			
Food Fish	14.21		
Carcass and egg sales	2.00		

Notes: 1. Average 1998 dollars per fish for commercial fisheries and per angler day for recreational fisheries.
2. Carcass sale value estimated to be $0.10 per pound for whole body fish less eggs.

Source: Study.

understandings for assumptions about salmon production, allocation agreements, and protection of natural runs.[11]

There are three basic distribution patterns of Columbia River Basin produced salmon: north turning fish (fall chinook), south turning fish (coho), and some that tend to migrate in either direction (some of the above). Steelhead tend to scatter and migrate as far as Russian waters. Harvest rates by geographic area depend on migration patterns, as well as historic fishing patterns, and on international and historic treaties and management policies. The distributional criteria assume that future harvests will reflect recent historical catches in ocean and terminal fisheries where these fish migrate. This assumption, however, depends on the present Columbia River user group allocations. The distributional assumptions under conditions of "80's runs" are used to assign harvestable fish to user groups (Table V-3).

The anadromous fish forecasting analysis results in a fairly large share of summer steelhead destined to the Snake River watershed escaping fisheries and returning to hatcheries as surplus. The default use of this surplus is for food fish, egg, and carcass sales. There may be fishery management opportunities to convert these sales to harvest opportunities, however drastic changes to management regimes to take advantage of these opportunities were not included in the analysis.

4. Historical John Day Dam Pool Area Anadromous Fish Production

John Day Dam construction started in 1958 and river flow started impounding in 1967. The Pool reached operating levels in 1968. Prior to construction, records indicate that 30,000 adult fall chinook salmon spawned in the area flooded by the dam. In 1978 the states, federal agencies, and U.S. Army Corps of Engineers reached agreement on chinook mitigation due for the John Day project. The agreed mitigation was for 30,000 adult fall chinook spawners and all harvested fish produced by this annual escapement. The mitigation agreement was derived by taking the difference between the fish counts at The Dalles and McNary dams for the years 1957-1964 and adding an additional 20 percent safety factor. At first, the fisheries agencies reared tule fall chinook salmon for John Day mitigation. Recently, upriver bright fall chinook are being reared in the hatcheries and a portion of the smolts are transported upriver for acclimation and release in the Hanford Reach so returning adults will provide an upstream fishery for the tribes. Releases of juvenile fish from the various facilities compensated under John Day dam mitigation currently represent approximately 11.9 million smolts annually. These releases are approximately 4 times greater than the anticipated smolt yield from 30,000 adult spawning naturally.

11. Harvest allocations set by fishery management plans and treaties can change. For example, the U.S. is presently negotiating with Canada on harvest allocations. It is not clear what new harvest allocations will result from these negotiations. For that reason, existing U.S. and Indian tribal agreements are the base used in allocating harvests. In the case of inriver tribal agreements, harvests are now less than treaty rights for 50 percent of harvestable summer steelhead stocks. Future distributional allocations were modified to attain a 50 percent share within 25 years.

Table V-3. Distributional Assumptions

		Distributional Assumptions					
		Spring/Summer Chinook		Fall Chinook		Summer Steelhead	
Geographic Region/Fishery		Hatchery	Wild	Hatchery	Wild	Hatchery	Wild
Ocean							
Alaska							
	Commercial	3.198%	14.017%	6.804%	7.206%	0.000%	0.000%
	Recreational	0.000%	0.000%	0.011%	0.012%	0.033%	0.065%
British Columbia							
	Commercial	6.397%	28.039%	28.350%	30.027%	1.084%	2.143%
	Recreational	0.640%	2.805%	2.268%	2.402%	0.000%	0.000%
Washington Ocean							
	Commercial	1.279%	5.606%	5.342%	5.658%	0.000%	0.000%
	Recreational	1.279%	5.606%	2.374%	2.514%	0.000%	0.000%
Washington Puget Sound							
	Commercial	0.640%	2.805%	0.001%	0.001%	0.000%	0.000%
	Recreational	0.000%	0.000%	0.001%	0.001%	0.000%	0.000%
Oregon							
	Commercial	0.640%	2.805%	1.781%	1.886%	0.000%	0.000%
	Recreational	0.640%	2.805%	0.594%	0.629%	0.033%	0.065%
California							
	Commercial	0.000%	0.000%	0.001%	0.001%	0.000%	0.000%
	Recreational	0.000%	0.000%	0.001%	0.001%	0.000%	0.000%
Columbia Basin Inland							
Recreational							
	Mainstem	0.000%	0.000%	1.187%	1.257%	7.414%	14.659%
	Tributary	0.000%	0.000%	0.000%	0.000%	22.242%	43.977%
Commercial							
	Gillnet	0.000%	0.000%	14.245%	15.088%	0.000%	0.000%
	Tribal	4.264%	18.689%	31.283%	33.134%	19.770%	39.090%
Other		3.838%	16.822%	0.172%	0.182%	0.000%	0.000%
Hatchery							
	Egg & Carcass	38.593%	0.000%	2.793%	0.000%	24.713%	0.000%
	Food Fish	38.593%	0.000%	2.793%	0.000%	24.713%	0.000%

Notes: 1. Distributional assumptions for wild stocks are calculated as a percentage of hatchery stocks less egg and carcass and food fish. This is done to ensure that all harvestable wild fish are captured in the analysis.
2. Distribution patterns reflect 1980's runs modified to meet existing fishery management plans and international and Indian treaty obligations.

Source: Study.

5. Harvest Forecast

Harvest forecast methods utilize passage models to characterize the survival through the hydrosystem and then incorporate the passage model results into life cycle models to characterize the effect of water management actions on adult population levels. Specific changes in harvestable adults and returning spawners related to water management alternatives were based on estimates for a selected few wild origin index stocks provided by Anderson et al. (1999) and summarized by Willis (1999).[12,13] The effects to the index stocks were used as a basis to extend the analysis to represent all wild and hatchery origin stocks. The methods and forecast results are explained in two following sections related to effects from passage improvements and habitat re-creation in the John Day Dam pool area.

a. Passage Improvement

To produce impact estimates of John Day Dam actions on adult population levels, Anderson et al. (1999) simplified the analysis provided by PATH to produce mean equilibrium harvest and spawner levels under a range of hypotheses.[14] For the more detailed analyses of actions at the John Day project, Anderson et al. (1999) further refined the life-cycle analyses to produce only the difference in adults under two actions. This simplification arises from the assumption that actions taken at the John Day project will not affect survivals in other life stages (e.g., ocean survival or egg to smolt survival) with the result that these survivals will cancel out when comparing two actions.

The equilibrium measure of the population is the level at which the spawning recruits of a brood are exactly sufficient to replace their parental brood. With typical salmon life-cycle models, in

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12. Pertinent excerpts of these studies are repeated for clarity in discussing the economic valuation and harvest forecast methods.
13. Harvestable fish at maximum sustained yield population levels were provided over a range. Point estimates were consistently selected from the many variables and assumptions mentioned as contributing to the uncertainty in modeled results. The results are highly variable depending upon the assumptions for: 1) smolt survival rates, 2) D levels (i.e., differential mortality between transported and non-transported juvenile migrants related to assumptions regarding the effects of transportation on fish survival), 3) extra mortality factors (i.e., assumptions regarding effects of hatchery-related bacterial kidney disease, ocean climate regime shifts, or cumulative hydro-system stresses), and 4) adult survival rates (Anderson et al. 1999). For example, using different values and assumptions for Snake River spring chinook gave results ranging from 76 percent to 23 percent for the natural river drawdown without flood control facilities. The substantial range means the harvest forecasts in this report should not necessarily be used to represent actual harvests that would occur if the dam alterations occurred. However, the comparisons of the alternatives to each other should be valid.
14. The Plan for Analyzing and Testing Hypotheses (PATH) process intended to identify, address, and (to the maximum extent possible) resolve uncertainties in the fundamental biological issues surrounding recovery of endangered spring/summer chinook, fall chinook, and summer steelhead stocks in the Columbia River Basin. The PATH process used a committee approach to discuss and resolve issues. The committee membership were representatives of agencies that regulate or have an interest in anadromous fish runs. The committee was staffed by consultants. The PATH modeled the survival of some of the Snake River wild spring and summer chinook stocks and fall chinook stocks to determine the effects of the hydrosystem actions. PATH developed a quantitative decision analysis framework for spring/summer chinook and a preliminary framework for fall chinook. The process also developed a qualitative analysis for summer steelhead using comparisons of the likely effects of actions on spring/summer chinook as a guide to the probable response of summer steelhead. The PATH decision analysis focused on the probability to which alternative hydrosystem actions contributed to preventing extinction and aiding recovery of stocks either listed or proposed for listing.

the absence of environmental variations and a constant harvest rate, the equilibrium population level is a stable point that a stock will approach over time. Simply put, the equilibrium is a measure of the number of fish a habitat can maintain with a specific set of management actions including hydrosystem operations and fisheries regulations.

The time period of anadromous fish recovery to reach equilibrium may differ depending on physical conditions, fishery management, and other factors. An undefined time period, following altered river hydraulics, may be needed to return the river bed conditions to acceptable spawning habitat quality. Whereas the river will cut through the soft sediments relatively quickly and create the surface layer of appropriate spawning gravels, it may take a large flood to scour the streambed to sufficient depth to clear embedded fine materials. Similarly, a demographic lag of many generations may occur at current commercial fish harvest rates prior to achieving spawning levels approaching full capacity. Following the geomorphologic changes, the transition for a drawdown to reestablish a macro invertebrate community to supply food to rearing fall chinook may take 10 years, according to research provided by PATH. Anderson et al. (1999) also suggests a 10 year demographic response for fall chinook to reach an equilibrium level. Given the suggested ranges for geomorphologic changes, microinvertebrate changes, and demographic responses, the time period to recovery for economic calculations is assumed to be 30 years.

Modeling assumptions were required for estimating the near term changes between existing conditions and the Year 30 equilibrium levels. For wild anadromous fish stocks, a Logistic Growth Curve was fit to Year 0 starting values and Year 30 equilibrium levels (Seber 1984). For hatchery stocks, the rate of change in survival rates for the first generation of wild stocks (Year 0 existing conditions and estimated Year 5 equilibrium levels) was applied to existing hatchery origin anadromous fish survival rates. Hatchery production is assumed to be constant, so typical spawner-recruit relationships do not apply.

It was necessary to expand the provided index wild stocks from the upper Columbia River and Snake River to represent all other significant wild stocks affected by the John Day Dam alterations.[15] Also, the actions intended to increase wild anadromous fish survival would increase hatchery fish survival so it was necessary to add all effected hatchery origin stocks. The changes in survival rates for the index wild stocks are used to model similar life cycle stocks, e.g. Snake River spring chinook estimates are used for Snake River summer chinook. There are no estimates for increased steelhead survival rates given in the Anderson et al. (1999) report. The assumption used for the economic analysis is that summer and winter steelhead will survive at 37 percent of comparable spring/summer chinook stocks.[16] The equilibrium harvests for all the

15. There are probably beneficial effects for middle Columbia River stocks, as well as upper Columbia River and Snake River stocks. However, no biological modeling for these stocks was performed for this preliminary assessment. Therefore, the survival rates are assumed not to change for the middle Columbia spring chinook and summer steelhead spawning in the tributaries, such as John Day, Umatilla, etc.
16. The PATH process did not develop harvest and spawner impact information for steelhead, but did provide a comparative analysis between summer steelhead and spring/summer chinook. The analysis concluded actions that benefit spring/summer chinook are likely to benefit steelhead as well. The relative decline for summer steelhead has been proportionately less than the decline for spring/summer chinook. It would be reasonable to presume that the response to actions that address the factors for decline would be proportionately less (to the same degree as during the decline) for summer steelhead than for spring chinook. It was therefore assumed that

affected stocks are shown in Table V-4. The largest increase in harvests results from recreating spawning areas accessible to fall chinook in the John Day Dam pool area.

b. John Day Dam Pool Area Habitat Improvement

A review of potential effects on spawning adult salmonids from improved habitat resulting from John Day Dam water management actions was completed by Willis (1999). Table V-5 shows the forecasted spawners and number of fish available for ocean and terminal fisheries harvest. The existing pool area spawning is only for fall chinook salmon. The drawdown to spillway crest or natural river levels is also assumed to only benefit the fall chinook race that extensively uses large mainstem rivers for spawning.

6. Regional Economic Impacts

The changed direct, indirect, and induced effects from increased anadromous fish harvest after stocks reach equilibrium resulting from John Day Dam water management alternatives ranges from $26.5 million personal income (Action B1, or the natural river drawdown alternative) to $20.6 million personal income (Action B2, the spillway crest alternative). Including flood control with the natural river alternative (Action B3) would slightly increase the natural river alternative to $25.6 million personal income (***Table IV.1***).

The fishing industry and supporting industries may gain a total of 717 annual jobs, once equilibrium is attained after 30 years, under the natural river alternative (Table V-6). Under the spillway alternative, a total of 557 jobs may be gained.

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the survival rate response for steelhead would be reduced relative to that for spring chinook by a proportionality constant reflecting the relative historical decline. The current best estimates of the ratios of recent survival rates to historical survival rates are 11.2x for spring/summer chinook and 4.1x for steelhead (Cooney 1999). Using those ratios, the proportional change in steelhead survival rates is about 0.37 times the change in spring chinook survival rates.

Table V-4. Equilibrium Level Harvestable Fish Resulting From John Day Dam Hydrosystem Actions

	Historical	Harvest at Equilibrium Year 30		
	Harvest	Harvest		Difference
Species/Stocks	Year 0	A1	Bx	A1-Bx
Natural River (B1)				
Wild Index Stocks				
SR Spring Chinook	1,115	7,068	64,524	57,456
SR Fall Chinook	1,408	6,548	81,140	74,592
Hanford Reach Fall Chinook	75,877	214,640	160,574	(54,066)
UC Spring Chinook	369	369	460	91
New Habitat Fall Chinook	7,019	7,019	95,930	88,911
Other Wild Stocks				
SR Summer Chinook	195	1,234	11,265	10,031
SR Summer Steelhead	4,115	12,242	90,685	78,443
UC Summer Chinook	673	673	839	166
UC Fall Chinook	14,293	40,432	30,247	(10,184)
UC Summer Steelhead	8,055	8,055	8,790	735
UC Spring Chinook (Other)	0	0	0	0
Hatchery Stocks				
SR Spring Chinook	2,124	4,013	22,247	18,235
SR Fall Chinook	3,409	5,483	35,581	30,098
SR Summer Chinook	116	220	1,217	998
SR Summer Steelhead	76,953	102,283	346,770	244,487
UC Summer Chinook	85	85	88	3
UC Fall Chinook	13,363	17,435	15,849	(1,587)
UC Summer Steelhead	55,926	55,926	56,777	851
UC Spring Chinook (All)	1,925	1,925	2,004	79
Spillway Crest (B2)				
Wild Index Stocks				
SR Spring Chinook	1,115	7,068	57,076	50,008
SR Fall Chinook	1,408	6,548	78,394	71,846
Hanford Reach Fall Chinook	75,877	214,640	154,249	(60,391)
UC Spring Chinook	369	369	416	47
New Habitat Fall Chinook	7,019	7,019	46,822	39,803
Other Wild Stocks				
SR Summer Chinook	195	1,234	9,965	8,731
SR Summer Steelhead	4,115	12,242	80,517	68,274
UC Summer Chinook	673	673	759	86
UC Fall Chinook	14,293	40,432	29,056	(11,376)
UC Summer Steelhead	8,055	8,055	8,435	380
UC Spring Chinook (All)	0	0	0	0
Hatchery Stocks				
SR Spring Chinook	2,124	4,013	19,884	15,871
SR Fall Chinook	3,409	5,483	34,473	28,990
SR Summer Chinook	116	220	1,088	868
SR Summer Steelhead	76,953	102,283	315,077	212,794
UC Summer Chinook	85	85	87	2
UC Fall Chinook	13,363	17,435	15,663	(1,773)
UC Summer Steelhead	55,926	55,926	56,365	439
UC Spring Chinook (All)	1,925	1,925	1,966	41

Table V-4. (continued)

Species/Stocks	Historical Harvest Year 0	Harvest at Equilibrium Year 30 Harvest A1	Harvest Bx	Difference A1-Bx
Natural River With Flood Control (B3)				
Wild Index Stocks				
SR Spring Chinook	1,115	7,068	62,092	55,024
SR Fall Chinook	1,408	6,548	81,140	74,592
Hanford Reach Fall Chinook	75,877	214,640	160,574	(54,066)
UC Spring Chinook	369	369	437	68
New Habitat Fall Chinook	7,019	7,019	95,930	88,911
Other Wild Stocks				
SR Summer Chinook	195	1,234	10,840	9,607
SR Summer Steelhead	4,115	12,242	87,365	75,123
UC Summer Chinook	673	673	797	124
UC Fall Chinook	14,293	40,432	30,247	(10,184)
UC Summer Steelhead	8,055	8,055	8,604	549
UC Spring Chinook (All)	0	0	0	0
Hatchery Stocks				
SR Spring Chinook	2,124	4,013	21,476	17,463
SR Fall Chinook	3,409	5,483	35,581	30,098
SR Summer Chinook	116	220	1,175	956
SR Summer Steelhead	76,953	102,283	336,422	234,139
UC Summer Chinook	85	85	87	3
UC Fall Chinook	13,363	17,435	15,849	(1,587)
UC Summer Steelhead	55,926	55,926	56,562	636
UC Spring Chinook (All)	1,925	1,925	1,984	59

Notes:
1. UC - Upper Columbia; SR - Snake River.
2. A1 refers to the John Day Dam and the lower Snake River dams as they are currently operated.
3. Bx refers to either John Day Dam Action B1, B2, or B3. B1 refers to natural river drawdown. B2 refers to drawdown to spillway crest. B3 refers to natural river drawdown with flood control. All actions assume the lower Snake River dams are being breached in tandem with the John Day Dam.
4. Harvest includes both ocean and inriver harvest.
5. Snake River and Upper Columbia steelhead are estimated based on the assumption that steelhead survive at 37 percent of the rate change for spring and summer chinook.
6. Hatchery stocks rate change assumes one five year increment rate change of comparable species wild stock.
7. Equilibrium year for wild and hatchery stocks is year 30 and year 5 respectively.
8. Year 0 information is from most recent 10 year historical average.

Source: Study; TAC; Anderson et al. (1999), Tables 29, 31, 34, 35, 38, 39, 41, and 42.

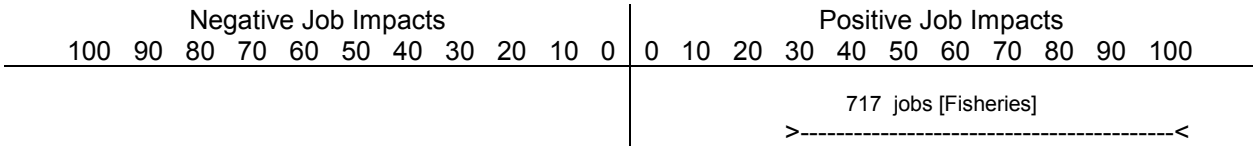
Table V-5. Available Adults to Terminal Fisheries From Increased Habitat Capacity in the John Day Reservoir Under Various Drawdown Scenarios

	Spawner Capacity (#)	Smolt Yield (100 Smolts/Spawner)	Hydro System Survival	Potential Adult Returns	Fish Available to Fishery	
					Terminal	Ocean
Existing Conditions	5,500	550,000	314,500	10,700	5,200	1,819
Natural River	55,000	5,500,000	3,790,000	129,000	74,000	21,930
Spillway Crest	31,100	3,110,000	1,960,000	66,600	35,500	11,322

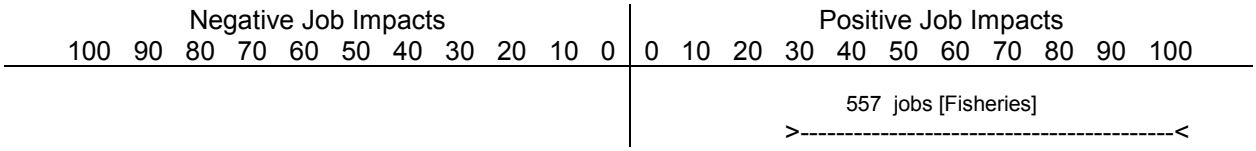
Note: Potential adult returns is ocean escapement.
Source: Willis (1999) and Study.

Table V-6. Employment Effects of Anadromous Fish Due to John Day Dam Pool Water Management Alternatives

Natural River Drawdown Alternative (B1), Over 100 Years



Spillway Crest Alternative (B2), Over 100 Years



Source: Study.

Table V-7. Changed Regional Economic Impacts (RED Benefits) for Selected Project Years by Commercial and Recreational Fisheries From Anadromous Fish Harvests

					Recreational											
Hydrosystem		Commercial			Ocean			Inriver			Total			Total		
Actions		Income	Sales	Jobs	Income	Sales	Jobs	Income	Sales	Jobs	Income	Sales	Jobs	Income	Sales	Jobs
Action B1 Less Action A1																
	Year 5	$3.81	$11.83	103	$0.09	$0.27	2	$7.97	$24.75	216	$8.05	$25.02	218	$11.86	$36.85	321
	Year 10	$3.96	$12.31	107	$0.09	$0.27	2	$8.16	$25.35	221	$8.25	$25.62	223	$12.21	$37.93	330
	Year 25	$12.84	$39.88	347	$0.42	$1.30	11	$13.18	$40.93	357	$13.60	$42.23	368	$26.43	$82.11	715
	Year 50	$12.87	$39.98	348	$0.42	$1.31	11	$13.20	$41.00	357	$13.62	$42.30	368	$26.49	$82.28	717
	Year 100	$12.87	$39.98	348	$0.42	$1.31	11	$13.20	$41.00	357	$13.62	$42.30	368	$26.49	$82.28	717
	Max	$12.87	$39.98	348	$0.42	$1.31	11	$13.20	$41.00	357	$13.62	$42.30	368	$26.49	$82.28	717
	Min	$3.81	$11.83	103	$0.09	$0.27	2	$7.97	$24.75	216	$8.05	$25.02	218	$11.86	$36.85	321
	Median	$12.87	$39.98	348	$0.42	$1.31	11	$13.20	$41.00	357	$13.62	$42.30	368	$26.49	$82.28	717
	Mean	$11.73	$36.43	317	$0.38	$1.18	10	$12.55	$38.98	340	$12.93	$40.15	350	$24.65	$76.58	667
Action B2 Less Action A1																
	Year 5	$3.37	$10.48	91	$0.08	$0.25	2	$6.93	$21.52	187	$7.01	$21.77	190	$10.38	$32.24	281
	Year 10	$3.24	$10.07	88	$0.06	$0.19	2	$7.09	$22.02	192	$7.15	$22.21	193	$10.39	$32.28	281
	Year 25	$9.00	$27.95	243	$0.22	$0.68	6	$11.34	$35.23	307	$11.56	$35.91	313	$20.56	$63.86	556
	Year 50	$9.01	$27.98	244	$0.22	$0.68	6	$11.36	$35.29	307	$11.58	$35.97	313	$20.59	$63.95	557
	Year 100	$9.01	$27.98	244	$0.22	$0.68	6	$11.36	$35.29	307	$11.58	$35.97	313	$20.59	$63.95	557
	Max	$9.01	$27.98	244	$0.22	$0.68	6	$11.36	$35.29	307	$11.58	$35.97	313	$20.59	$63.95	557
	Min	$3.37	$10.48	91	$0.08	$0.25	2	$6.93	$21.52	187	$7.01	$21.77	190	$10.38	$32.24	281
	Median	$9.01	$27.98	244	$0.22	$0.68	6	$11.36	$35.29	307	$11.58	$35.97	313	$20.59	$63.95	557
	Mean	$8.26	$25.67	224	$0.20	$0.62	5	$10.81	$33.58	293	$11.01	$34.20	298	$19.27	$59.87	521
Action B3 Less Action A1																
	Year 5	$3.70	$11.50	100	$0.09	$0.27	2	$7.63	$23.69	206	$7.71	$23.96	209	$11.41	$35.46	309
	Year 10	$3.85	$11.97	104	$0.09	$0.27	2	$7.81	$24.27	211	$7.90	$24.54	214	$11.75	$36.51	318
	Year 25	$12.55	$38.99	340	$0.42	$1.30	11	$12.61	$39.19	341	$13.03	$40.49	353	$25.59	$79.49	692
	Year 50	$12.58	$39.09	340	$0.42	$1.31	11	$12.64	$39.25	342	$13.06	$40.56	353	$25.64	$79.65	694
	Year 100	$12.58	$39.09	340	$0.42	$1.31	11	$12.64	$39.25	342	$13.06	$40.56	353	$25.64	$79.65	694
	Max	$12.58	$39.09	340	$0.42	$1.31	11	$12.64	$39.25	342	$13.06	$40.56	353	$25.64	$79.65	694
	Min	$3.70	$11.50	100	$0.09	$0.27	2	$7.63	$23.69	206	$7.71	$23.96	209	$11.41	$35.46	309
	Median	$12.58	$39.09	340	$0.42	$1.31	11	$12.64	$39.25	342	$13.06	$40.56	353	$25.64	$79.65	694
	Mean	$11.46	$35.61	310	$0.38	$1.18	10	$12.01	$37.32	325	$12.39	$38.50	335	$23.86	$74.11	646

Notes: 1. RED benefits expressed as personal income and sales are in millions of 1998 dollars, and jobs are full and part-time employment.
2. Sales and jobs are estimated using state level ratio averages for Washington, Oregon, and Idaho.
3. Hatchery return sales are included in commercial fisheries.
4. Due to the maximum being reached by year 30 and remaining constant (equilibrium) the median is always equal to the maximum.
5. Max, min, median, and mean are calculated starting from project year 1 to project year 100.

Source: Study.

VI. RECREATION AND TOURISM EFFECTS

The economic effects on recreation and tourism are based on estimated visitor day changes for fishing and non-fishing recreation activities that would be created by dam breaching or drawdown to spillway crest. Drawdown to spillway crest is assumed to reduce fishing and non-fishing visitor days by twenty percent. Fishing and non-fishing visitor days increase after breaching because of the attraction of the natural river in place of the reservoir.

Currently, the reservoir attracts mainly local residents for both fishing and non-fishing recreation activities (persons living within 50 miles of the reservoir). The free flowing Columbia river is projected to attract a much larger number of nonresident recreationists to the region.[17] Thus, the share of nonlocal visitors or i.e. export trips rises sharply after breaching but is unchanged with drawdown to spillway crest. Increases in export trips bring new spending into the study region causing the economy to expand. The positive economic effect of breaching is magnified because both the number of visitors and the share of visitors that are nonlocal increases simultaneously. Changes in recreation trips by local residents are not relevant for regional impact measurement because they are expected to spend on other local products if the reservoir is removed.

Table VI-1 shows visitor days, export visitor days, and export trips for fishing and non-fishing recreation activities. The conversion of visitor days to export visitor days is based on the estimated share of nonlocal visitors among the anglers or non-fishing recreationists. The share of anglers on John Day reservoir that is nonlocal is estimated at 0.146 while the share of non-fishing recreationists that is nonlocal is estimated at 0.217.[18] Conversion of export visitor days to export trips is accomplished by dividing export visitor days by 3.36 for fishing and by 2.62 for non-fishing recreation. These divisors convert visitor days into trips using the estimated number of days per trip for fishing and non-fishing recreation respectively. Export trips by anglers and other recreationists are the driving force to stimulate the local economy.

Table VI-2 shows the estimated current and future contribution to the Downriver Subregion economy by fishing and non-fishing recreation activities at John Day reservoir. These are the baseline projections that constitute the outcome without either drawdown to spillway crest or breaching of John Day Dam. For example, fishing at John Day reservoir is currently creating an estimated 22 jobs in the Downriver Subregion while non-fishing recreation creates about 255 jobs. Baseline jobs are projected to rise over time to 61 fishing related jobs and 1.18 thousand non-fishing related jobs in 100 years.

The basis for the economic impacts shown in Table VI-2, and throughout the recreation section, is estimated export trips and the direct, indirect, and induced economic effects of export trips derived from recreation surveys and input-output models built for the nearby lower Snake River reservoirs (McKean 1999).

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17. Based on AEI's contingent behavior mail survey for the four Lower Snake River reservoirs. The assumption is that survey results applicable to the lower Snake River apply to the John Day Dam pool area. The lower Snake River area may become an attraction to outside the region recreationists, resulting from dam removal. These changes may not take place as a result of natural river flows in the John Day Dam pool area. Further recreation demand studies for this area may be required to forecast anticipated recreational use.
18. Based on AEI's fishing and recreation spending mail surveys on the four Lower Snake River Reservoirs (McKean 1999).

Table VI-1. John Day Reservoir: Fishing and Non-Fishing Recreational Activities Visitor Days, Export Visitor Days and Export Trips

	Fishing			Non-Fishing		
Year	Visitor Days	Export Visitor Days	Export Trips	Visitor Days	Export Visitor Days	Export Trips
5	502,719	73,397	21,844	2,224,869	482,797	184,274
10	528,887	77,218	22,982	2,401,542	521,135	198,906
25	615,847	89,914	26,760	3,020,283	655,401	250,153
50	793,701	115,880	34,488	4,425,645	960,365	366,552
100	1,318,333	192,477	57,285	9,502,428	2,062,027	787,033
Maximum	1,318,333	192,477	57,285	9,502,428	2,062,027	787,033
Minimum	477,847	69,766	20,764	2,061,193	447,279	170,717
Median	793,701	115,880	34,488	4,425,645	960,365	366,552
Mean	831,699	121,428	36,139	4,914,804	1,066,512	407,066

Source: Study.

Table VI-2. John Day Reservoir: Economic Effects of Fishing and Non-Fishing Recreational Activities

	Fishing			Non-Fishing		
	Sales		Personal Income	Sales		Personal Income
Year	($ Million)	Jobs	($ Million)	($ Million)	Jobs	($ Million)
5	2.21	23	0.56	21.71	275	5.82
10	2.32	24	0.59	23.43	297	6.29
25	2.70	28	0.69	29.47	374	7.91
50	3.48	38	0.89	43.18	547	11.59
100	5.79	61	1.47	92.70	1,175	24.89
Maximum	5.79	61	1.47	92.70	1,175	24.89
Minimum	2.10	22	0.53	20.11	255	5.40
Median	3.48	38	0.89	43.18	547	11.59
Mean	3.65	38	0.93	47.95	608	12.87

Source: Study.

Table VI-3 shows the projected economic effects of drawdown to spillway crest. These projections are simply twenty percent reductions in the baseline values shown in Table VI-2.

Table VI-4 shows the estimated adjustment to visitor days with breaching of John Day Dam. Initially the visitor days declines (to 80 percent of normal for fishing and 71 percent of normal for non-fishing recreation), accounting for rehabilitation of recreation facilities and the newly exposed reservoir bottom. Eventually, the visitor days increases above the baseline estimates, almost doubling after 100 years in the case of fishing visitor days.

Table VI-7 also shows the combined effect of the rising trend in visitor days and the much increased share of non-local visitors that occurs with breaching. The expansion factors shown are applied to the baseline data in Table VI-2 to estimate the new levels of sales, jobs, and

Table VI-3. John Day Reservoir: Economic Effects of Fishing and Non-Fishing Recreational Reductions with Drawdown to Spillway Crest

	Fishing			Non-Fishing		
Year	Decrease in Sales ($ Million)	Decrease in Jobs	Decrease in Personal Income ($ Million)	Decrease in Sales ($ Million)	Decrease in Jobs	Decrease in Personal Income ($ Million)
5	-0.44	-5	-0.11	-4.34	-55	-1.16
10	-0.46	-5	-0.12	-4.69	-59	-1.26
25	-0.54	-6	-0.14	-5.89	-75	-1.58
50	-0.70	-7	-0.18	-8.64	-109	-2.32
100	-1.16	-12	-0.29	-18.54	-235	-4.98
Maximum	-0.42	-4	0.00	-4.02	-51	-1.08
Minimum	-1.16	-12	-0.29	-18.54	-235	-4.98
Median	-0.70	-7	-0.18	-8.64	-109	-2.32

Source: Study.

Table VI-4. John Day Reservoir: Adjustment and Expansion Factors for Fishing and Non-Fishing Visitor Days with Breaching

Year	Fraction of Current Fishing Visitor Days	Fraction of Current Non-Fishing Visitor Days	Expansion of Current Fishing Export Trips	Expansion of Current Non Fishing Export Trips
5	0.82	0.71	3.82	2.63
10	0.85	0.72	3.96	2.67
25	0.98	0.79	4.56	2.93
50	1.23	0.95	5.73	3.52
100	1.94	1.38	9.04	5.12
Maximum	1.94	1.38	9.04	5.12
Minimum	0.80	0.71	3.73	2.63
Median	1.23	0.95	5.73	3.52
Mean	1.28	0.98	5.95	3.64

Source: Study.

personal income that are projected to occur with breaching. The new levels of economic activity with breaching are shown in Table VI-5. Subtracting the levels of baseline economic activity (Table VI-2) from the new levels shown in Table VI-5 reveals the effect of breaching on economic activity. Thus, the estimated changes in economic activity with breaching are shown in Table VI-6.

The recreation and supporting industry may gain 567 annual jobs resulting from changes in the John Day Dam pool. Most of these additional jobs would be attained from changing river uses (Table VI-7). Under the spillway crest alternative, 65 annual jobs may be lost to the region.

Table VI-5. John Day Reservoir: Economic Levels After Fishing and Non-Fishing Activity Changes with Breaching

	Fishing			Non-Fishing		
Year	New Level of Sales ($ Million)	New Level of Jobs	New Level of Personal Income ($ Million)	New Level of Sales ($ Million)	New Level of Jobs	New Level of Personal Income ($ Million)
5	8.44	88	2.14	57.10	723	15.31
10	9.19	95	2.34	62.56	793	16.79
25	12.31	128	3.15	86.35	1,096	23.18
50	19.94	212	5.10	151.99	1,925	40.80
100	52.34	551	13.29	474.62	6,016	127.44
Maximum	52.34	551	13.29	474.62	6,016	127.44
Minimum	7.83	82	1.98	52.88	671	14.20
Median	19.94	212	5.10	151.99	1,925	40.80
Mean	23.51	247	5.98	191.87	2,433	51.49

Source: Study.

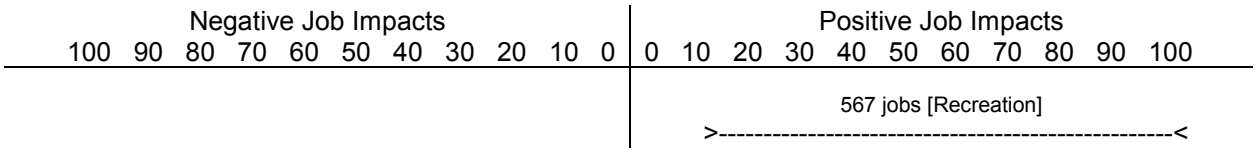
Table VI-6. John Day Reservoir: Economic Effects of Breaching on Fishing and Non-Fishing Recreation Activities

	Fishing			Non-Fishing		
Year	Sales Created ($ Million)	Jobs Created	Personal Income Created ($ Million)	Sales Created ($ Million)	Jobs Created	Personal Income Created ($ Million)
5	6.23	65	1.58	35.99	448	9.49
10	6.87	71	1.75	39.13	496	10.50
25	9.61	100	2.46	56.88	722	15.27
50	16.46	174	4.21	108.81	1,378	29.21
100	46.55	490	11.82	381.92	4,841	102.55
Maximum	46.55	490	11.82	381.92	4,841	102.55
Minimum	5.73	60	1.45	32.77	416	8.80
Median	16.46	174	4.21	108.81	1,378	29.21
Mean	19.86	209	5.05	143.95	1,825	38.63

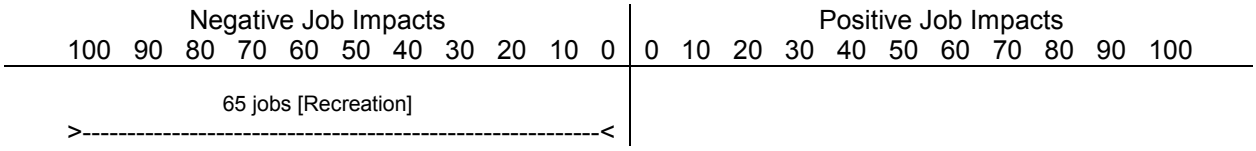
Source: Study.

Table VI-7. Employment Effects on Recreation Due to John Day Dam Pool Water Management Alternatives

Natural River Drawdown Alternative (B1), Over 100 Years



Spillway Crest Alternative (B2), Over 100 Years



Source: Study.

VII. IMPLEMENTATION AND AVOIDANCE EFFECTS

Implementation spending is defined as the difference in construction spending between the baseline (existing conditions) and the other alternatives under consideration. The estimated direct, indirect, and induced economic effects for implementation result from these construction spending differences (positive or negative). Implementation effects are shown for both the natural river alternative (breaching) and the drawdown to spillway crest alternative.

1. Distributing the Construction Purchases Across Sectors

As might be expected, none of the available construction sectors in the IMPLAN input-output model closely match that required for dam breaching. The "new highways and streets" sector includes some activities similar to earthen dam breaching. The IMPLAN "new highways and streets" purchases allocation is defined for the 1982 Bureau of Economic Analysis (BEA) Commodity Code 11.0400. That code specifies the construction of "new highways and streets."

The "new government facilities" construction sector is specifically defined to include construction of dams and reservoirs (among many other things). The IMPLAN "new government facilities" purchases allocation is defined for the BEA Commodity Codes 11.0701-11.0704, which include (1) new military facilities, (2) new dams and reservoirs, (3) other new conservation and development facilities, and (4) other new nonbuilding facilities.

Because economic impact estimates based on the IMPLAN coefficients would more properly apply to a mix of construction activities that differ widely from dam breaching, an alternative engineering-based estimate specific to dam breaching is used to estimate economic impacts of implementation.

2. Construction Impacts Based on an "Industry Sources" Distribution of Purchases

A more accurate depiction of construction spending than that implied by the broad construction classifications in IMPLAN was provided by an industry expert. A senior estimator at a well known international construction firm provided a typical budget for earthen dam breaching activities described in Corps publications. Physical labor was 35 percent of expenditures, management labor was 10 percent, equipment was 35 percent and 20 percent was accounted for by materials, fuel and subcontractors. Engineering design was an additional 10 percent on top of the construction costs.

Imports for construction activity would be substantial for the lower Snake River region. It was assumed that 50 percent of physical labor, all management services, all engineering professionals, and 90 percent of heavy equipment would be imported from outside the lower Snake River Subregion. It was assumed that purchases from suppliers of materials and fuels and from subcontractors would be spent 100 percent within the subregion. Factoring in the engineering design (professional services) into the above percentages results in: physical labor (both local household sector and import sector) 31.5 percent, management services (import sector) nine percent, engineering services (import sector) 10 percent, heavy equipment (both

local and import sector) 31.5 percent, materials, fuel or subcontractors (local wholesale sector) 18 percent.

The resulting budget allocation is: imports (import sector) 58.6 percent, local labor (household sector) 20.25 percent, local equipment (government facilities construction sector) 3.15 percent, local materials, fuel and materials (wholesale sector) 18 percent. Imports of construction engineering and management services to the lower Snake River region has no multiplier effect in the region and will accrue to a national or international construction company of unknown location. It is assumed that 50 percent of the physical labor will commute from nearby population centers for this short term project and will not create a significant impact in the lower Snake River region.

Multipliers specific to the construction budget allocation have been calculated by weighting the multipliers for the respective IMPLAN sectors (households, wholesale, and government facilities construction) by the sector shares calculated above. The resulting multipliers are: business sales 0.9993; employment 8.108 jobs/$million; and personal income 0.2072. These multipliers are applied to the change in spending between the baseline and each of the two alternatives in order to estimate the direct, indirect, and induced effects on business sales, employment, and personal income.

3. The Direct, Indirect, and Induced Effects of Implementation

The following information and assumptions are made concerning implementation spending:

1. structural modifications:
    a. spillway crest: $425 million spent evenly over 5 years ($85 million per year for 5 years).
    b. natural river: $1,200 million spent evenly over 5 years ($240 million per year for 5 years).

2. rip rap:
    a. spillway crest: $350 million spent evenly over 5 years ($70 million per year for 5 years).
    b. natural river: $600 million spent evenly over 5 years ($120 million per year for 5 years).

3. combined cost of road and railroad repairs:
    a. spillway crest: $200 million spent over a one year period after drawdown
    b. natural river: $200 million spent over a one year period after drawdown

4. bridges and culverts:
    a. spillway crest: $45 million spent evenly over 5 years ($9 million per year for 5 years).
    b. natural river: $95 million spent evenly over 5 years ($19 million per year for 5 years).

5. utilities:
    a. spillway crest: $6 million spent over a one year period
    b. natural river: $6 million spent over a one year period

6. cultural resource inventory:
    a. spillway crest: $55 million spent evenly over 5 years ($11 million per year for 5 years).
    b. natural river: $95 million spent evenly over 5 years ($19 million per year for 5 years).

7. treaty fishing site relocation:
    a. spillway crest: $30 million spent over a one year period
    b. spillway crest: $30 million spent over a one year period

8. erosion and wildlife:
    a. spillway crest: $45 million spent evenly over 5 years ($9 million per year for 5 years).
    b. natural river: $60 million spent evenly over 5 years ($12 million per year for 5 years).

9. modification of recreation sites:
    a. spillway crest: $20 million spent over a one year period
    b. natural river: $20 million spent over a one year period

In summary, the combined implementation spending for one-year duration projects is $256 million for either the spillway crest alternative or the natural river (breaching) alternative. The combined annual implementation spending for five-year duration projects is $184 million per year for the spillway crest alternative and $410 per year for the natural river alternative.

The estimated direct, indirect, and induced effects of the one-year implementation projects is $255.82 million in business sales, 2.08 thousand jobs, and $53.05 million in personal income to the local economy. These one-year impacts are the same for either the spillway crest or the natural river alternatives.

The estimated direct, indirect, and induced effects of the five-year implementation projects for the spillway crest alternative are $183.87 million in business sales, 1.49 thousand jobs, and $38.13 million in personal income to the local economy. These annual impacts continue for a five year time period.

The estimated direct, indirect, and induced effects of the five-year implementation projects for the natural river alternative (breaching) are $409.70 million in business sales, 3.32 thousand jobs, and $84.96 million in personal income to the local economy. These annual impacts continue for a five year time period.

4. Avoided Cost Effects

Avoided Cost is defined as the difference in spending between the baseline (existing) operating conditions and the operating costs of other alternatives under consideration. The estimated direct, indirect, and induced economic effects for the avoided costs result from these differences in operation spending (positive or negative). Avoided costs include reduced spending due to the shut down of lock operations, hydroelectric operations and the visitor center. These impacts are expected to occur only under the breaching alternative.

The geographical distribution of job losses or gains and other spending changes is not known. It was assumed that changes in jobs and spending would occur primarily in the Downriver Subregion (except for imports which are accounted for in the input-output model calibration). The direct, indirect, and induced economic effects were estimated using the Downriver Subregion input-output model.

The distribution of spending reductions or increases by type of input also was unknown and a specific set of multipliers for the alternatives could not be created. Instead, the IMPLAN "Government NEC" sector (functions of government sectors not elsewhere considered) was used to estimate the direct, indirect, and induced economic effects of the avoided costs.

5. The Direct, Indirect, and Induced Effects of the Avoided Costs

The business sales multiplier for the Downriver Subregion for "Government NEC" is 2.955. The employment multiplier for the Downriver Subregion for Government NEC is 44.31 jobs/$million. The personal income multiplier for the Downriver Subregion for government NEC is 1.261.

The estimated change in annual operating spending of -$10 million is multiplied by these multipliers to calculate the direct, indirect, and induced economic impacts of the avoided costs. Thus, the impact on business sales is -29.5 million per year, the impact on jobs is -443 jobs, and the impact on personal income is -$12.6 million per year. These negative avoided cost impacts would presumably continue indefinitely.

Avoidance and implementation projects may generate 5.40 thousand annual jobs in the first five years under the natural river alternative (Table VII-1). There would be a long term loss of 443 jobs. Under the spillway crest alternative, a total of 3.57 thousand jobs may be gained in the first five years and a total of 443 long term jobs lost.

Table VII-1. Employment Effects of Avoidance and Implementation Projects Due to John Day Dam Pool Water Management Alternatives

Natural River Drawdown Alternative (B1), Over 100 Years

Negative Job Impacts												Positive Job Impacts										
100	90	80	70	60	50	40	30	20	10	0		0	10	20	30	40	50	60	70	80	90	100
443 jobs [Operations]												5,400 jobs [Construction]										
>----------<												>---<										

Spillway Crest Alternative (B2), Over 100 Years

Negative Job Impacts												Positive Job Impacts										
100	90	80	70	60	50	40	30	20	10	0		0	10	20	30	40	50	60	70	80	90	100
443 jobs [Operations]												3,568 jobs [Construction]										
>----------<												>---<										

Source: Study.

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